

USER'S MANUAL

**SERIES 4XXX DIGITAL THYRISTOR MAIN CONVERTER
FOR DC MOTOR WITH INDEPENDENT EXCITATION
DIRECT CURRENT FROM 250A TO 600A**

Contents

1. General description	5
2. Operating instructions, storage and transportation	6
3. Technical features	7
4. Installation and dimensions	8
5. Interfaces and converter status indication	11
5.1 Parallel interface X1	11
5.1.1 Digital inputs	11
5.1.2 Digital outputs	14
5.2 Analog interface X2	17
5.2.1 Differential analog input	17
5.2.2 Analog input for tachogenerator	17
5.2.3 Analog outputs	17
5.2.4 Others	18
5.3 Encoder interface - X3 и X4	18
5.4 Series interface X6	19
5.5 Power interface X7	19
5.5.1 Converter controlling block supply	20
5.5.2 Converter power part supply	20
5.5.3 Wound field power part supply	20
5.5.4 Motor wound field supply	20
5.5.5 Motor armature supply	20
5.6 Converter status indications	26
6. Converter adjustment	30
6.1 Work with special terminal or personal computer	30
6.2 Functional converter circuit	31
6.3 Converter parameteres	31
6.4 Parameter description	36
6.4.1 Group 01 – parameters for variable monitoring	36
6.4.2 Group 02 – converter parameters	38
6.4.3 Group 03 – protection parameters	41
6.4.4 Group 04 – motor parameters	45
6.4.5 Group 05 – speed regulator parameters	46
6.4.6 Group 06 – armature current parameters	47
6.4.7 Group 07 – EMF regulators and wound field current parameters	47
6.4.8 Group 08 – orientation stopping parameters	48
6.4.9 Group 09 – input parameters	49
6.4.10 Group 10 – output parameters	49
6.4.11 Group 11 – terminal parameters	50
6.4.12 Group 12 – error history	50
6.5 Errors in emergency mode	51
7. Assembling and connecting of the converter	53
7.1 General technical requirements to the assembling	53
7.2 Connecting of the converter	54
8. Connecting and adjusting of the converter	57
8.1 Checking the supply voltages	57
8.2 Primary converter adjusting	59
8.2.1 Primary adjusting of the speed feedback	59
8.2.2 Adjusting the parameters connected to the motor	60
8.3 Adjusting the wound field current	61
8.3.1 Adjusting the motor with known field data	61
8.3.2 Adjusting the motor with unknown field data	62
8.4 Starting of the converter in proportional mode	62
8.5 Checking the converter work in integral mode	65
8.6. Adjusting the device with unusual (unknown) motor	65
9. Possible troubles and remedy actions	73

1. General description

Series 4XXX are a new generation intelligent thyristor converters based on modern DSP/CPLD technologies. They are fed directly by the power mains and provide working in three zones, four quadrants speed control of motors. In the first zone speed is regulated according to constant torque, in the second zone to constant power and in the third zone with reduced of the power. There are speed regulation mode and orientation stopping in position mode. Adjusting all converter working modes is made by parameters system.

The converters of 4XXX series are designated for universal functioning and can be built-in in any machine regarded as highly requirements to the electrical device, also they have built-in functions, special for main devices of metacutting machines with CNC. They have also extended interface which gives different variants for user's work.

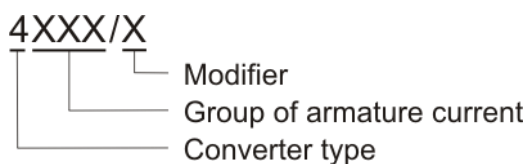
2. Operating instructions, storage and transportation

Thyristor converter series 4XXX can work , can be storage, and be transported in these conditions:

- Indoor temperature from 5° C to 50°C;
- Maximum relative humidity at 30° C less than 80 % ;
- Equipment should not be stored above 1000 m above the sea level;
- Environment – There must be no aggressive liquids, gases, vapour and electric conductive dust or easily flammable and explosive materials in the room where the equipment is saved;
- The equipment must not be exposed to direct solar radiation;
- Installation vibration limits frequency from 1 to 35 Hz and acceleration less than 4.9m/s^2 .

3. Technical features

The converter technical features are given in **Table 1**.



Structure of signification

Converter, type:	4025	4030	4040	4050	4060
Rated armature current, A	250	300	400	500	600
Maximum armature current, A	500	600	800	1000	1200
Power supply voltage, V	3x380, +10 / -15%				
Frequency of power supply voltage, Hz	45 ÷ 65				
Maximum voltage of the motor armature, V	440				
Maximum range of the nominal field current ¹ , A	4.7 / 12 / 20				
Dynamic current limitation of the armature	Programmable at law 1/n				
Maximum voltage of the wound field	320V _{DC} at U _F = 380V _{AC}				
Speed feedback sensor/position	Tachogenerator or encoder/encoder				
Speed reference	Analog/parallel code/series interface				
Position reference	Inner digital reference/series interface				
Range of speed regulation	1:10000				
Orientation stopping	Built-in				
Maximum voltage of the tachogenerator, V	± 193 at N _{MAX}				
Analog input	± 10V / 0 ÷ 10V / 0 ÷ -10V, 10K				
Analog outputs ²	2 outputs, ± 10V, 2 mA				
Digital inputs	18 inputs, ± 24V, 10mA				
Digital outputs	5 outputs relay type, 100V _{AC} / 0.3A, 24V _{DC} / 0.3A				
Series interfaces ³	RS 232C to 9600 bps RS422/RS 485 to 115 200 bps				
Working condition	Long lasting S1				
Degree of protection	IP 20				
Dimensions HxWxD, mm	500x261x350	575x383x365	575x383x420		

Table 1 Converters technical features

Notes:

¹ – standard range of rated wound field rated current is 20A. Other ranges are performed on order. At special order the converter can be performed with rated wound field current more than 20A;

² – the two analog outputs are option, which is assembled on order by the client;

³ – series interface **RS422/RS485** is an option, which is assembled on order by the client.

4. Installation and dimensions

The components of the converters of 4XXX series are placed on a metal corpus. The mounting holes are on the upper and lower part of the back side of the converter. The power elements are installed on the radiator, which is assembled at the bottom of the box. Over the power elements is fixed a plate on which are assembled pulse separating transformers, R-C groups, and fuses. The processor PCB with the interface terminals and indications are installed on the front panel. The dimensions and the locations of the interface and power terminals are given on **figure 1**, **figure 2**, and **figure 3**.

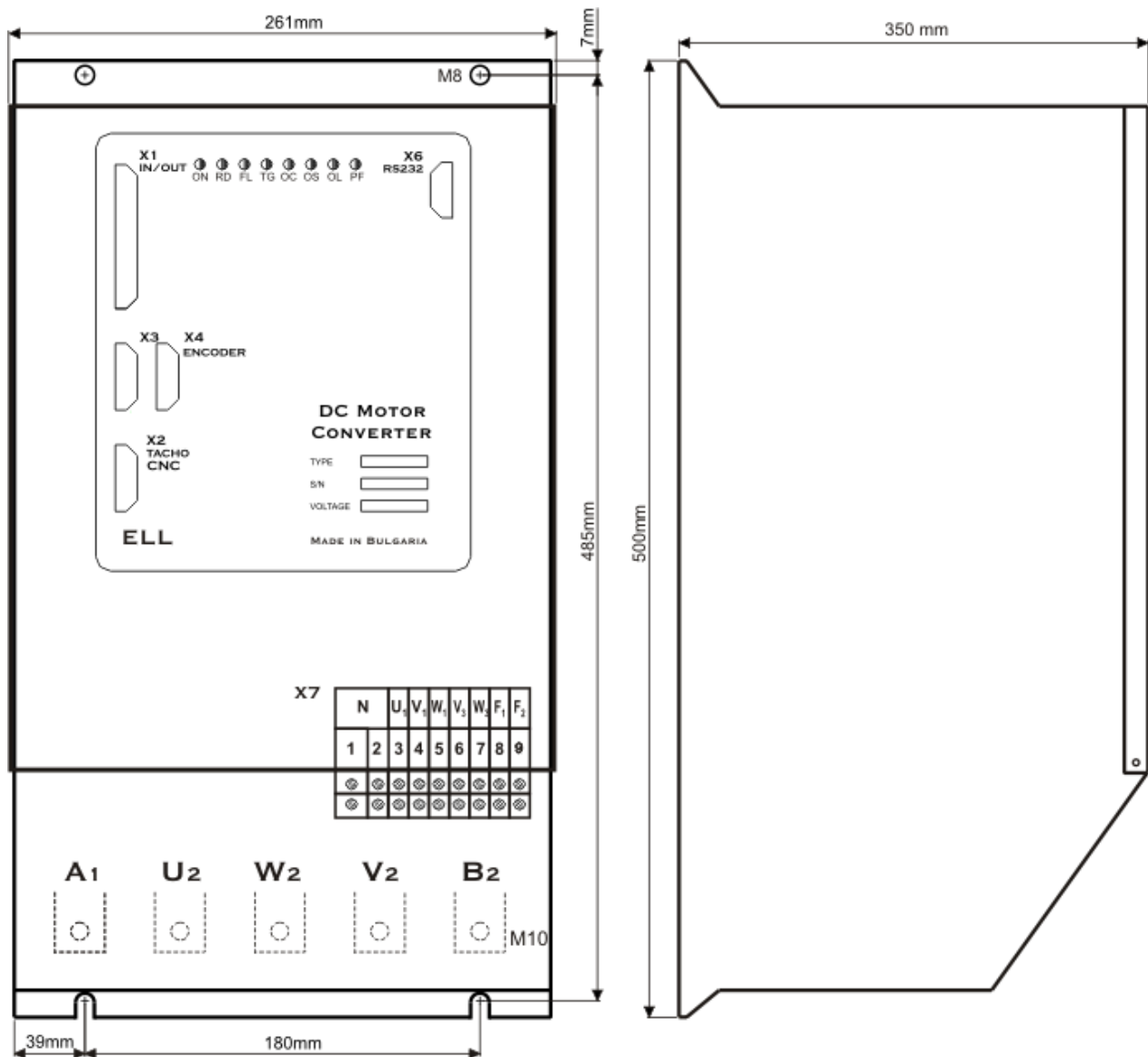


Figure 1 Connecting and overall dimensions of converters type 4025 and 4030

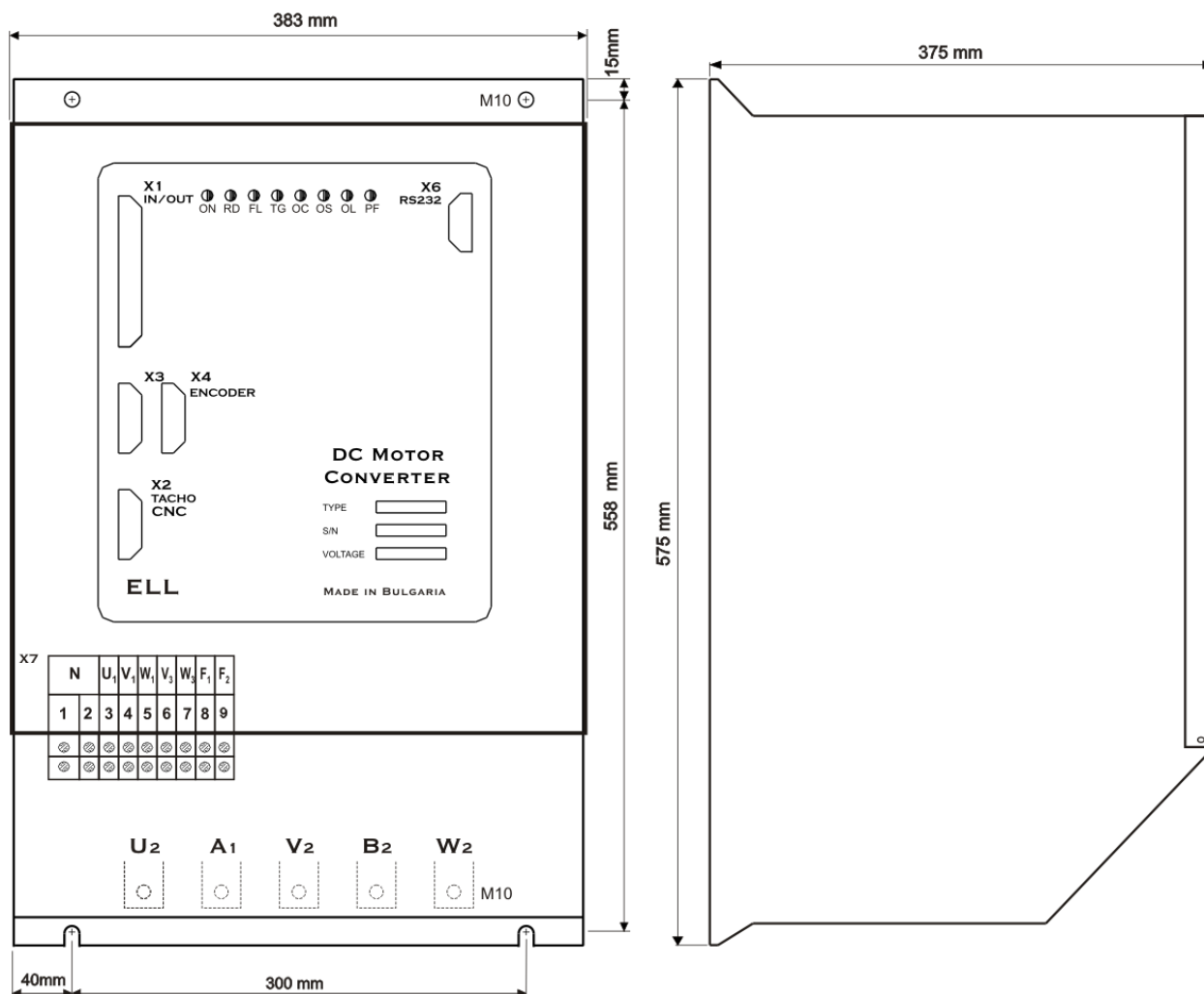


Figure 2 Connecting and overall dimensions of converter type 4040

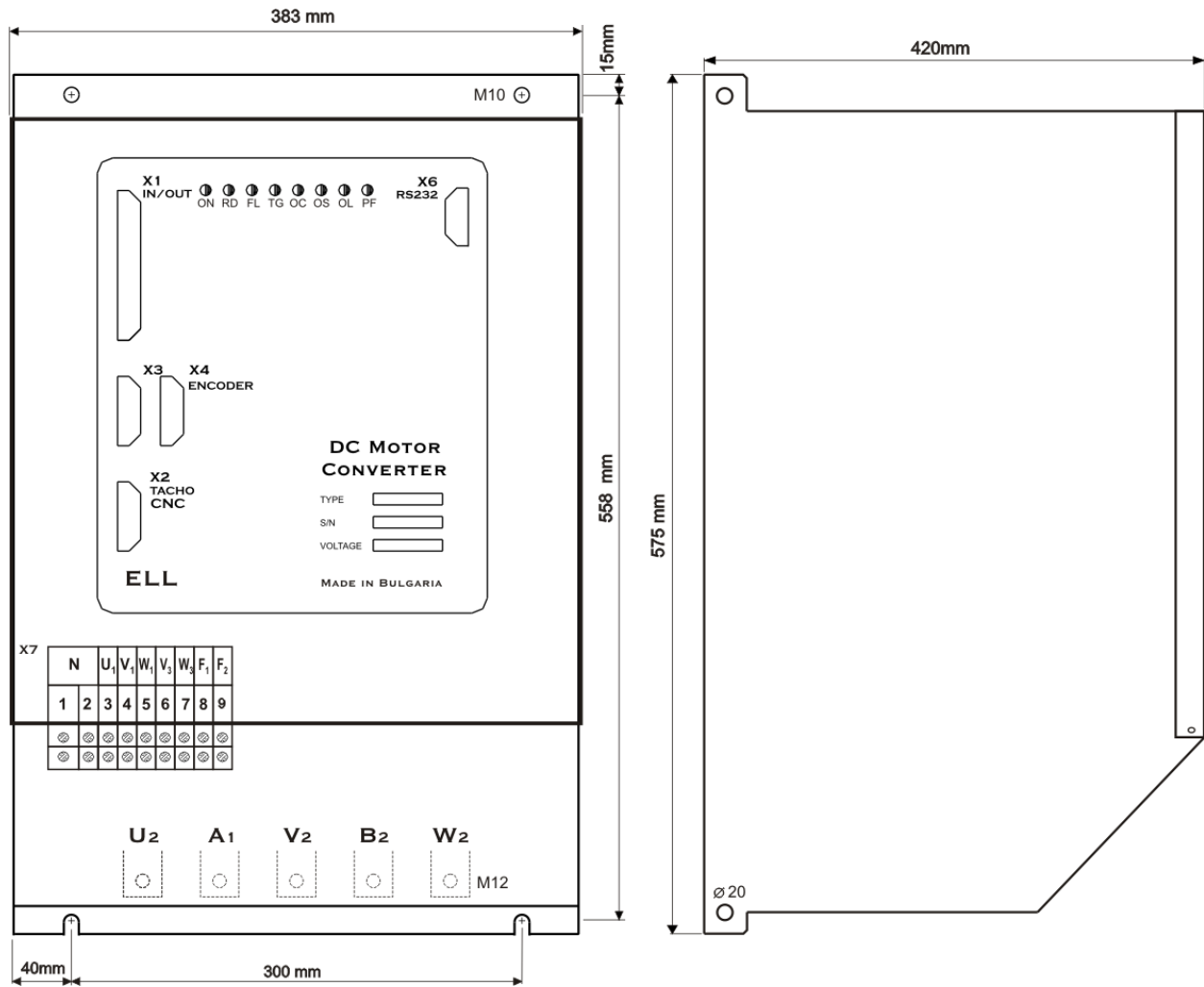


Figure 3 Connecting and overall dimensions of converters type 4050 and 4060

5. Interfaces and converter status indication

5.1 Parallel interface X1

Parallel interface **X1** consists of:

- 18 digital inputs: from **IN1** to **IN18**, galvanic isolated, voltage $\pm 24V_{DC}$ and input current to 10mA. Input signal low level from 0 to 7 V and high level from 13 to 30 V. They are used for control of the converter work and for speed reference by parallel digital code;
- 5 digital outputs: from **OUT1** to **OUT5** galvanic isolated, relay type, load capacity 0.3A at $100V_{AC}$ and 0.3A at $24V_{DC}$. They point to the outside control device the moment status of the converter.

Parallel interface **X1** is led to 37pin terminal on the upper left part of the face panel. In **table 2** is given correspondence between signals and parallel interface terminal **X1** pins, and in **figure 4** are given pin places and input structure.

X1.	Sign	Default function	X1.	Sign	Default function	X1.	Sign	Default function
1	-	-	14	IN11	Nmax1	27	IN14	TLL
2	OUT5.1	INPOS1	15	IN9	bit8	28	Uinp2	
3	OUT4.1	RD1	16	IN7	bit6	29	GND	
4	OUT3.1	SA1	17	IN5	bit4	30	GND	
5	OUT2.1	ZS1	18	IN3	bit2	31	Uinp1	
6	OUT1.1	TL1	19	IN1	bit0	32	IN12	Nmax2
7	IN17	ORCM	20	OUT5.2	INPOS2	33	IN10	bit9
8	IN15	SF	21	OUT4.2	RD2	34	IN8	bit7
9	IN13	RE	22	OUT3.2	SA2	35	IN6	bit5
10	Uinp2		23	OUT2.2	ZS2	36	IN4	bit3
11	+24V		24	OUT1.2	TL2	37	IN2	bit1
12	+24V		25	IN18	ON			
13	Uinp1		26	IN16	SR			

Table 2 Correspondence between terminal pins and signals of parallel interface **X1**. Default functions.

5.1.1 Digital inputs

Digital inputs are universal and they are grouped into two groups. In the first group are inputs from **IN1** to **IN12**, and in the second one from **IN13** to **IN18**. Inputs in each group can be selected individually by system outputs type **P** or **N**.

Power supply of digital inputs of each group can be performed in one of the following manner:

- By outer supply voltage **24 VDC**. Outer supply is connected to **Uinp1**(X1.13,31) for the first group and to **Uinp2**(X1.10,28) for the second group inputs;
- By inner operation voltage **24 VDC**. In this case, when the shunts position is **JP7 = JP8 = 1**, the voltage **24 VDC** is led to terminal pins X1.11, 12, and digital ground at pins X1.29, 30;
- By combination supply of digital inputs. In this case one of the groups digital inputs is supplied by outer voltage and the other by inner voltage **24V DC**.

The variations of digital input connection are given in **figure 5**.

Each of the digital inputs can be programmed to perform any function. Each function is given a number which is set when it is programmed. Part of these numbers are reserved. The reserved numbers activate at other software with built- in program modules for position and for control by series communication RS485/422. Numbers from 15 to 26 are reserved for user's function on order by the client. If to an input in given reserved number when it activates the converter does not react to it.

Digital inputs can perform following functions:

№	Function	№	Функция	№	Function
1	control signal ON	15	reserved	29	bit2
2	control signal RESET	16	reserved	30	bit3
3	control signal ORCM	17	reserved	31	bit4
4	reserved	18	reserved	32	bit5
5	reserved	19	reserved	33	bit6
6	reserved	20	reserved	34	bit7
7	reserved	21	reserved	35	bit8
8	reserved	22	reserved	36	bit9
9	control signal SF	23	reserved	37	bit10
10	control signal SR	24	reserved	38	bit11
11	control signal TLL	25	reserved	39	bit12
12	control signal TLH	26	reserved	40	bit13
13	control signal Nmax1	27	bit0		
14	control signal Nmax2	28	bit1		

Table 3 Functions given to the digital inputs

Acting of the functions given in **table 3** is following:

- **ON** – enabling converter work. When control signal **ON** activates regulators work is enabled, power part activates and, if any protection does not activate, the reference is performed. If the motor moves after receiving control signal **ON** the motor starts moving at the given speed;
- **RE** – reset the protections. When the control signal **RE** is received all protections are reset no matter what control signal **ON** is. It is recommended for realisation of control signal **RE** to use a single pulse lasting no less than 100 ms;
- **ORCM** – control signal of **orientation stopping**. When control signal **ORCM** activates, the rotating speed is fixed in so called “**searching speed**” which is set in parameter **P08.17**. After that it starts searching zero pulse from encoder in direction given by parameter **P08.15**. When there is zero pulse the speed is equal to this which is set in parameter **P08.14** and spindle is in position given by parameter **P08.13**;
- **SR** and **SF** – control signals of defining the motor rotating direction. They are used only when:
 - value of parameter **P02.14** = 0 – digital speed reference by parallel code;
 - value of parameter **P02.14** = 1 – analog speed reference at absolute value of control signal **Uref** in range from 0 to +10V or from 0 to -10V, as the sign does not point the rotating direction. The rotating direction is defined only of status of the inputs **SR** and **SF**. When the control signals **SF** and **SR** activate at the same time it is performed zero speed reference;
- **TLL** – control signal of torque limitation at low level. When control signal **TLL** activates, the motor torque is limited to the value set in parameter **P10.08** in range from 1% to 100% from rated motor current **Ia_{NOM}** (parameter **P04.05**);
- **TLH** – control signal of torque limitation at high level. When control signal **TLH** activates, the motor torque is limited to the value set in parameter **P10.07** in range from 10% to 100% from motor rated current **Ia_{NOM}** (parameter **P04.05**).
- **Nmax1** and **Nmax2** – control signals of choice of maximum speed of spindle rotating, in case when it is used a gearbox with alternative transmitting coefficient between the spindle and the motor and when the parameters **P02.16** = 1 and **P02.26** = 1. As a speed feedback is used an encoder, which is placed on the machine slindle. By control signals **Nmax1** and **Nmax2** it can be chosen to four different transmitting coefficients. Maximum spindle rotating speeds for given transmitting coefficients are set in parameters from **P02.22** to **P02.25**.
- **bit0** to **bit13** – parallel digital code bits of speed reference. The bit with biggest number is the most senior. Digital speed reference can be performed with different orders according to the client's requirement – e.g. 8, 10, 12 to 14 bits. It is allowed incomplete combinations (with

missing bits), as the most senior bit define the whole rate. Using the parallel digital code is enable when parameter **P02.14** = 0.

Notes:

1. Same function can be given to the several inputs. When they activate logical function **OR** is performed;
2. There is a possibility active logical level of each digital input to be invert.

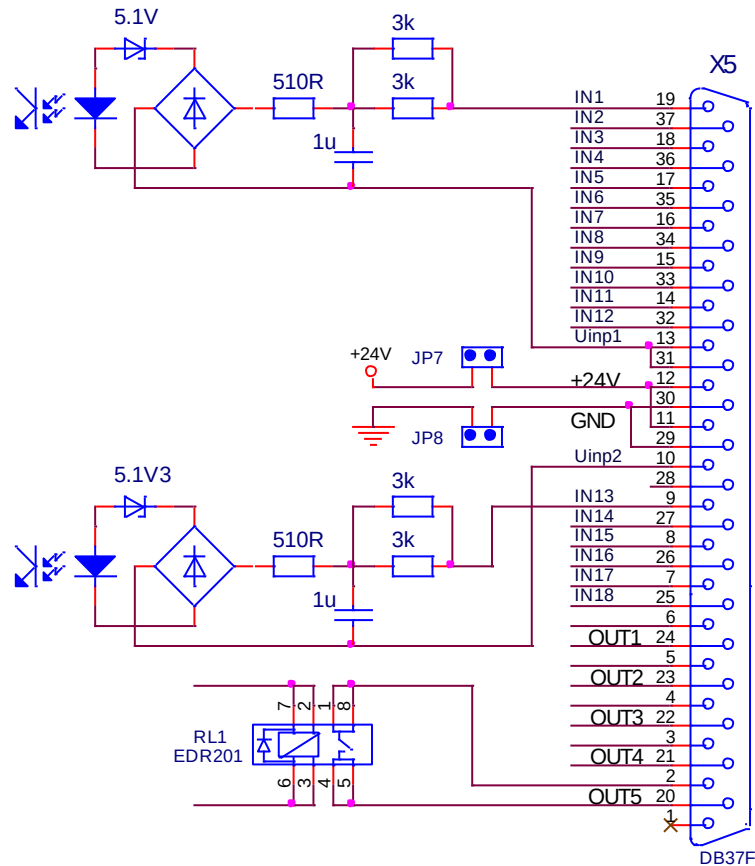


Figure 4 Correspondence between signals and pins of parallel interface terminal **X1** and electrical circuit of digital inputs and outputs.

By default the digital inputs of parallel interface **X1** are programmed with following functions:

- Control signals **ON** (X1.25), **RE** (X1.9), **ORCM** (X1.7), **SR** (X1.26), **SF** (X1.8) and **TLL** (X1.27) for control the converter work. The correspondence between inputs and control signals is given in the third column of the **table 2**;
 - Control signals **Nmax1** (X1.14) and **Nmax2** (X1.32) for choice of encoder maximum speed in case when a gearbox with alternative transmitting coefficient between spindle and motor is used. The correspondence between inputs and the control signals is given in the third column of the **table 2**;
 - 10 bits parallel code from **bit0** to **bit 9** for speed reference. The correspondence between inputs and control signals is given in the third column of the **table 2**.
- The default functions of programmed digital inputs are given in **table 2**.

5.1.2 Digital outputs

Each of the digital outputs can be programmed to perform any function. These functions point the current status of the converter. Digital outputs can receive the following functions:

№	Function
1	Torque limitation is reached TL
2	Zero speed is reached ZS
3	Given speed is reached SA
4	The converter is ready RD
5	Given position is reached INPOS

Table 4 Functions given to the digital outputs

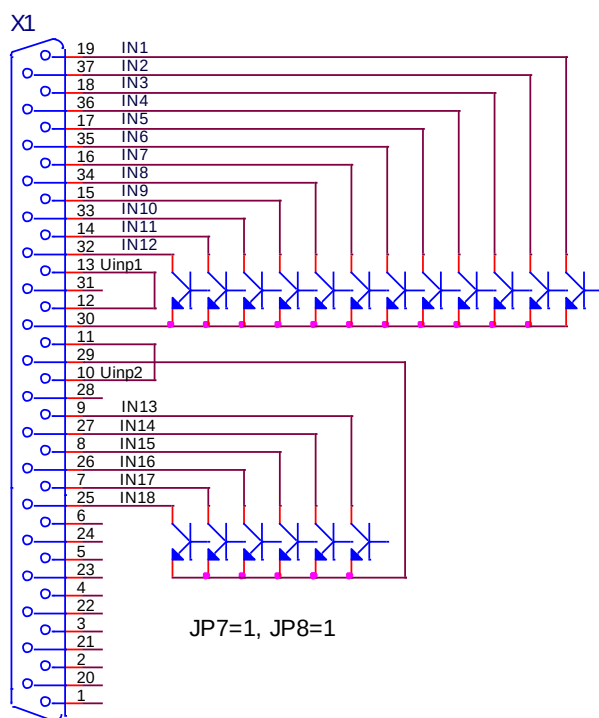
Activity of the functions given in **table 4** is following:

- **TL** – torque limitation is reached. It activates when the converter works in torque limitation mode by outer control signals **TLL** or **TLH**. Threshold of the torque limitation **TLL** is defined by the value of parameter **P10.08**, and of **TLH** by the value of parameter **P10.07**;
- **ZS** – zero speed is approached. It activates at rotating speeds under the speed given as value of parameter **P10.01** for time more than the value of parameter **P10.02**;
- **SA** – speed reference is approached. It activates at rotating speeds over the speed given as value of the parameter **P10.03** for time more than the value of the parameter **P10.04**. Function approached speed **SA** is enable for speeds more than the value of the parameter **P10.05**;
- **RD** – the converter is ready. Output **RD** activates 2 s after switching on the converter to power supply voltage;
- **INPOS** – given position is approached. It activates in orientation stopping mode when the given position is approached in range given as value of the parameter **P08.10** for time more than the value of the parameter **P10.06**.

Notes:

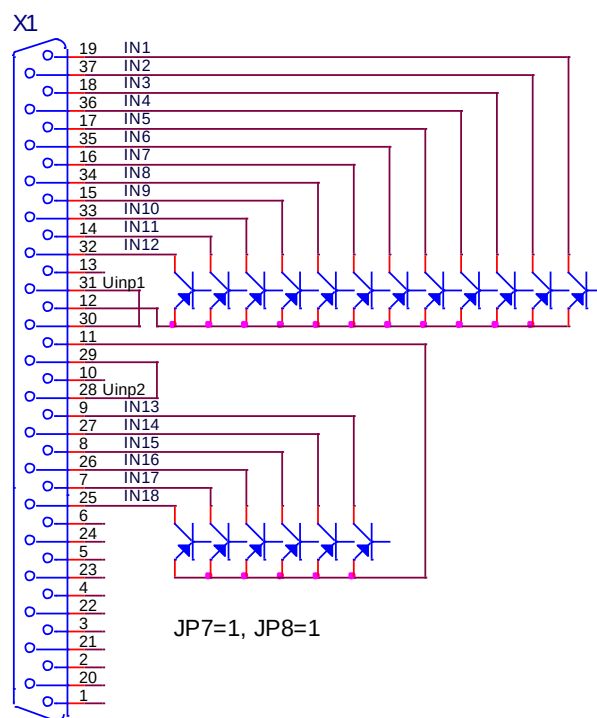
1. The same function can be given to the several outputs;
2. There is a possibility to choose active digital level of each digital output.

By default the digital outputs of the parallel interface **X1** are programmed with the functions **TL**(X1.6,X1.24), **ZS**(X1.5,X1.23), **SA**(X1.4,X1.22), **RD**(X1.3,X1.21) and **INPOS**(X1.2,X1.20). The correspondence between outputs and programmed functions by default is given in the third column of the **table 2**;



JP7=1, JP8=1

Variant 1

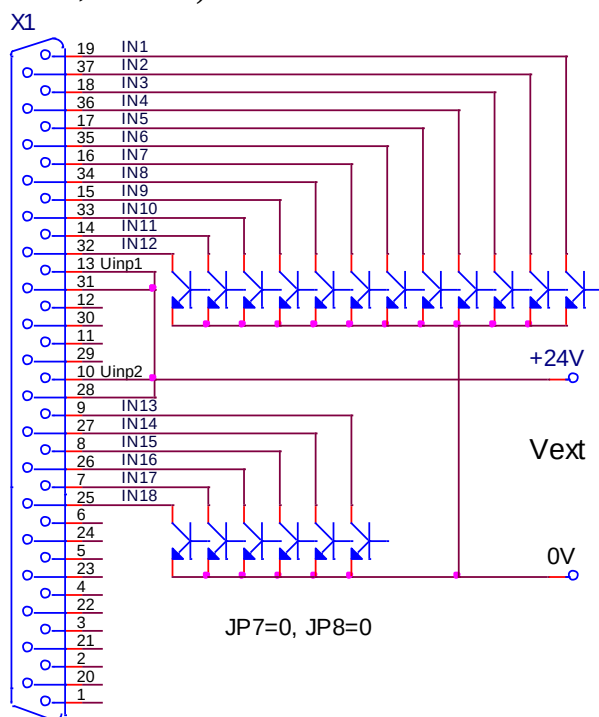


JP7=1, JP8=1

Variant 2

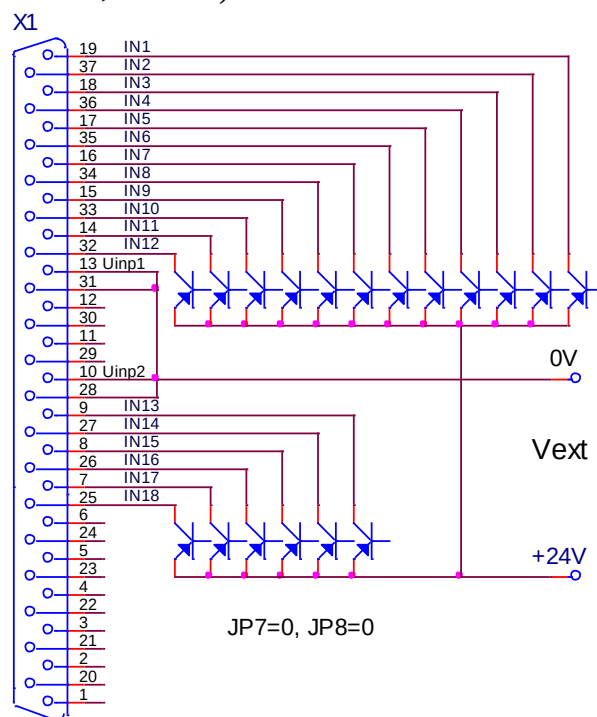
All inputs are selected by system outputs type **N** with inner power supply (**JP7 = 1, JP8 = 1**).

All inputs are selected by system outputs type **P** with inner power supply (**JP7 = 1, JP8 = 1**).



JP7=0, JP8=0

Variant 3

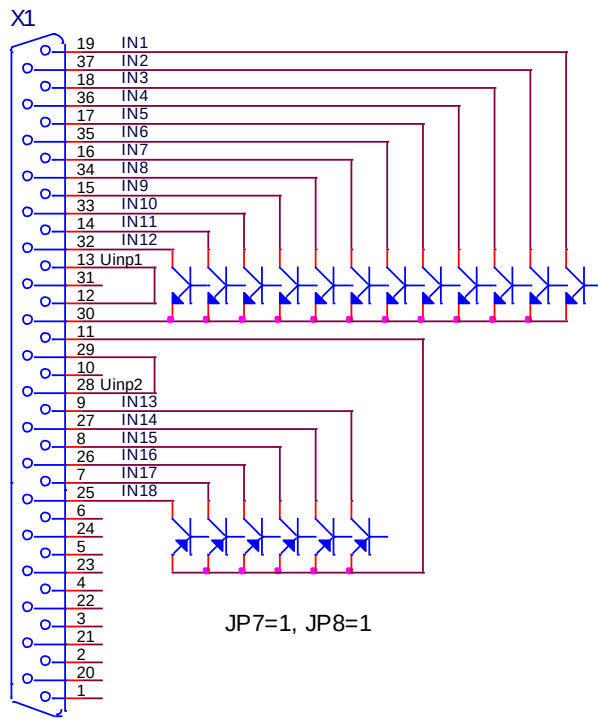


JP7=0, JP8=0

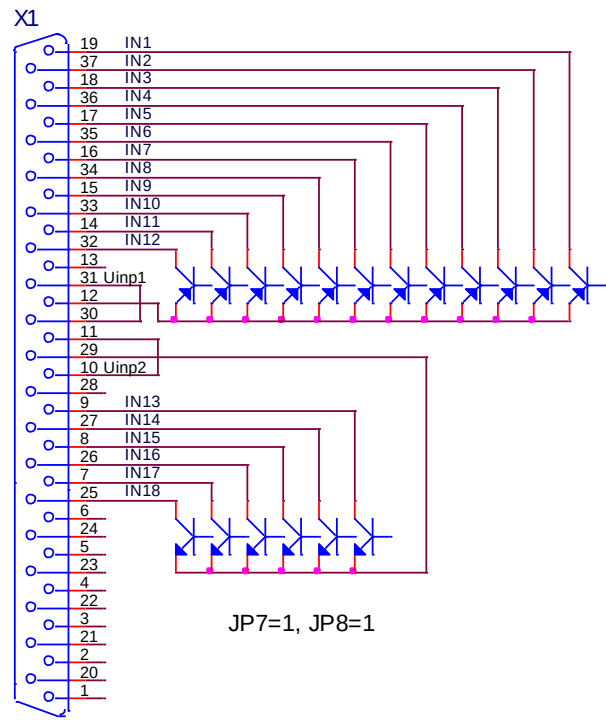
Variant 4

All inputs are selected by system outputs type **N** with outer power supply (**JP7 = 0, JP8 = 0**).

All inputs are selected by system outputs type **P** with outer power supply (**JP7 = 0, JP8 = 0**).



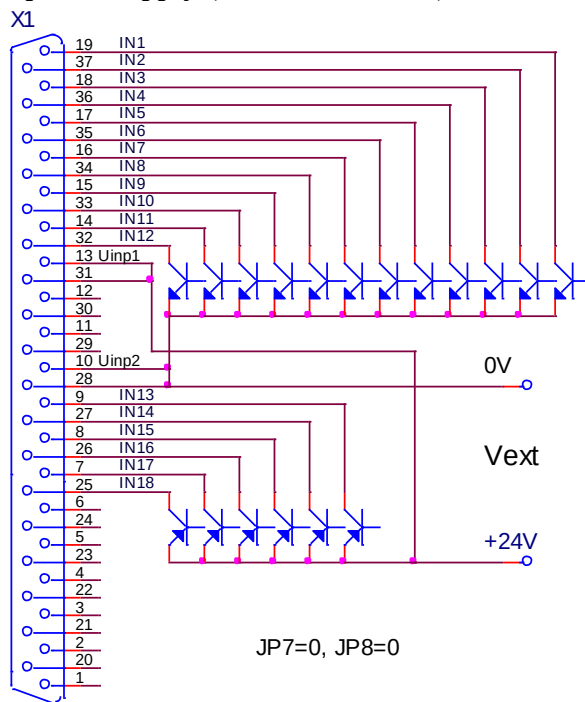
Variant 5



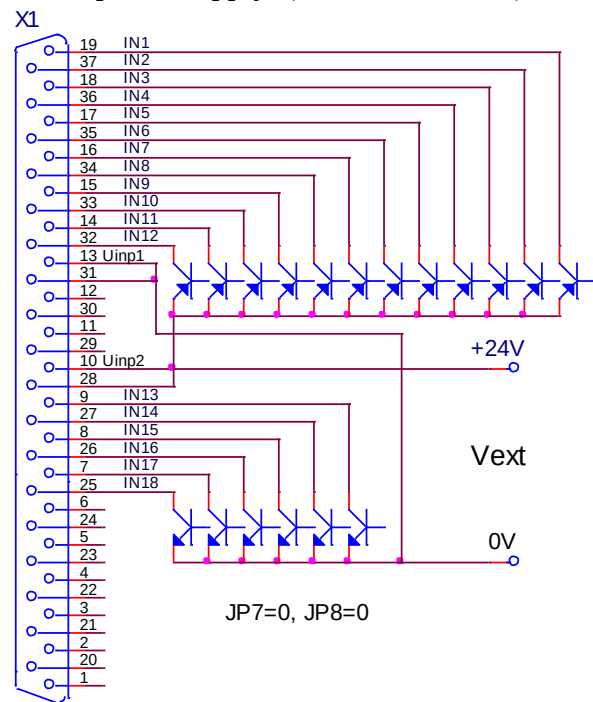
Variant 6

Inputs from **IN1** to **IN12** are selected by system outputs type **N**, others by system outputs type **P**, as all of them are with inner power supply (**JP7** = 1, **JP8** = 1)

Inputs from **IN1** to **IN12** are selected by system outputs type **P**, others by system outputs type **N**, as all of them are with inner power supply (**JP7** = 1, **JP8** = 1)



Variant 7



Variant 8

Inputs from **IN1** to **IN12** are selected by system outputs type **N**, others by system outputs type **P**, as all of them are with outer power supply (**JP7** = 0, **JP8** = 0)

Inputs from **IN1** to **IN12** are selected by system outputs type **P**, others by system outputs type **N**, as all of them are with outer power supply (**JP7** = 0, **JP8** = 0)

Figure 5 Variants of connecting digital inputs **IN1...IN18**

5.2 Analog interface X2

The analog interface **X2** is given in **figure 6** and it consists of:

- differential analog input **Uref**;
- analog input of speed feedback when it works with tachogenerator **Ubr**;
- two programmable analog outputs **AOUT1** and **AOUT2**.

№	Signal	№	Signal	№	Signal	№	Signal	№	Signal
1	Ubra	4	Urefb	7	+12V	10	EARTH	13	AGND
2	Ubrb	5	AOUT1	8	-12V	11	EARTH	14	AGND
3	Urefa	6	AOUT2	9	EARTH	12	-	15	AGND

Table 5 Correspondence between signals and analog interface terminal **X2** pins

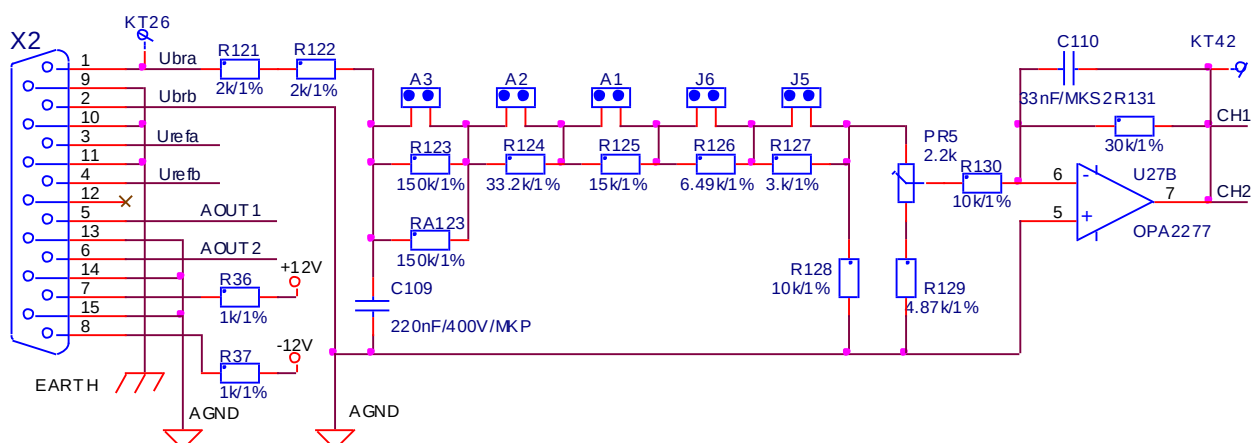


Figure 6 Correspondence between signals and analog interface terminal **X2** pins and electrical circuit of analog tachogenerator channel

5.2.1 Differential analog input

The differential analog input **Uref** (X2.3, X2.4) is used to speed control with analog reference when value of parameter **P02.14** = 1 or **P02.14** = 2.

5.2.2 Analog input for tachogenerator

The analog input for tachogenerator **Ubr** (X2.1, X2.2) is used in case when the sensor for speed feedback is tachogenerator. In **figure 6** is given the electric circuit of analog part of the channel of speed feedback with tachogenerator.

Changing the speed feedback coefficient is made by shunts **A1**, **A2**, **A3**, **J5** and **J6**. Shunt places on the processor plate is given in **figure 20**. In **table 6** is pointed shunt positions for different voltage ranges of tachogenerator at maximum speed. Precise adjustment of speed feedback coefficient at maximum speed is made by trimmer **RP5**, which place is given in **figure 20**.

5.2.3 Analog outputs

The two analog outputs are option which are assembled on client's order.

- **AOUT1**(X2.5) – analog output with maximum range $\pm 10V$ to analog ground **AGRND**(X2.13, X2.14 and X2.15) and admissible load capacity 2mA. The signal of the analog output **AOUT1** corresponds to the variable selected by parameter **P10.19**;
- **AOUT2**(X2.6) – analog output with maximum range $\pm 10V$ to analog ground **AGRND**(X2.13, X2.14, and X2.15) and admissible capacity 2mA. The signal of the analog output **AOUT2** corresponds to the variable selected by parameter **P10.20**.

Note: Analog output ranges can be adjusted by parameters **P10.21** and **P10.22**.

№	J5	J6	A1	A2	A3	Ubrmax[V] RP5 left	Ubrmax[V] RP5 right
1						7.0	10.3
2						10.0	14.5
3						13.5	19.0
4						17.5	23.0
5						22.0	30.0
6						28.5	39.0
7						31.5	44.0
8						40.0	56.0
9						48.0	63.0
10						57.0	74.0
11						66.0	90.0
12						86.0	114.0
13						105.0	130.0
14						123.0	157.0
15						150.0	193.0

Table 4 Tachogenerator voltage at maximum speed

Note: Dark field means that there is a shunt.

5.2.4 Others

- **AGND** (X2.2, 13, 14, 15) – analog ground. It is measured input and output analog signals to the ground;
- **+12V** (X2.7) и **-12V** (X2.8) – inner converter voltage used for motor speed control by potentiometer as it is given in **figure 19**;
- **EARTH** (X2.9,10,11) – converter frame.

5.3 Encoder interface - X3 и X4

Interface **X3** for encoder (ENC) is led to 15pin terminal at the left down part of the face panel. Input part circuit and pin places are given in **figure 7**. Terminal **X4** is an extension of **X3** for access of other device to encoder signals.

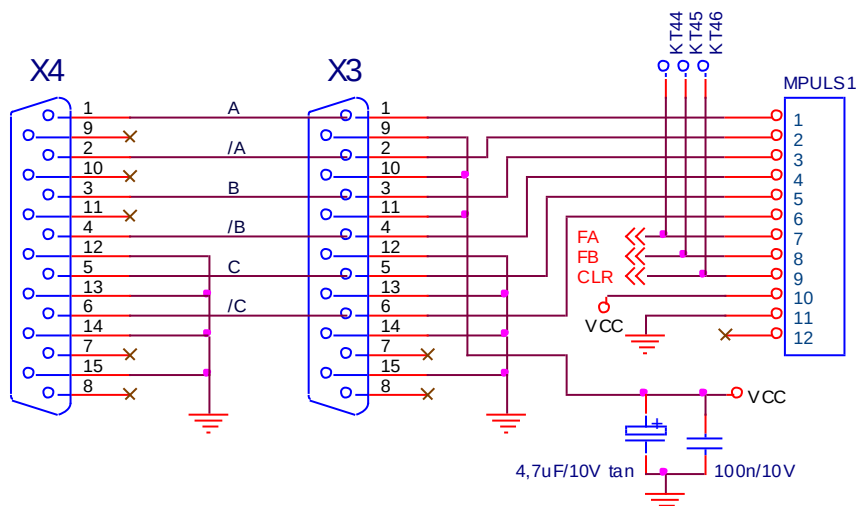


Figure 7 Electrical circuit and pin places of interface **X3** for encoder and its extension **X4**

№	Signal	№	Signal	№	Signal
1	A	6	/C	11	V _{CC} = +5V
2	/A	7	-	12	GND
3	B	8	-	13	GND
4	/B	9	V _{CC} = +5V	14	GND
5	C	10	V _{CC} = +5V	15	GND

Table 7 Correspondence between signals and pins of interface **X3**.

5.4 Series interface X6

Physical realization of series interface **X6** is standard **RS232C**, with communication speed 9600 bps. Series interface **X6** is led to 9 pin terminal at upper part of face panel. To supply special terminal is led voltage +5V (X6.9). Pin places of series interface **X6** are given in **figure 8**.

Series interface **RS422** or **RS485** is an option.

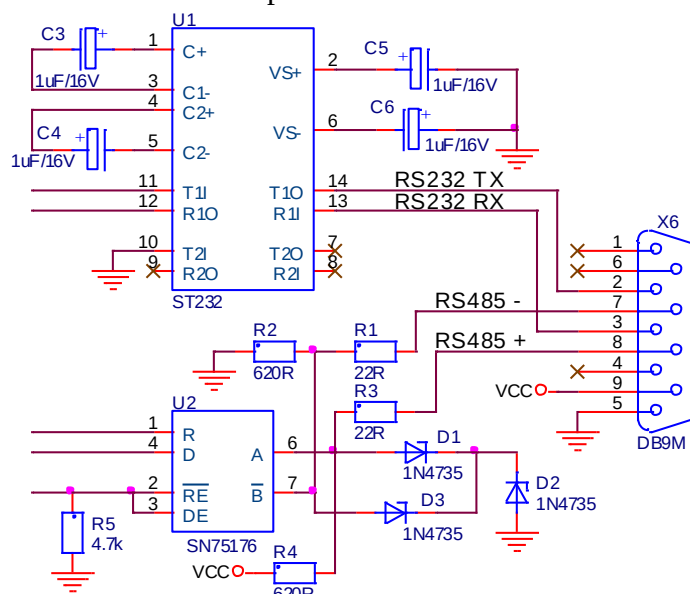


Figure10 Electrical circuit and pin places of series interface **X6**

5.5 Power interface X7

Power interface **X7** is led to a terminal and it connects the converter to power supply mains, to the motor armature, to the motor wound field and to outer protective and commutating devices. Power interface **X7** consists of:

- supply **U1**, **V1** and **W1** to the converter controlling block;
- supply **U2**, **V2** and **W2** to the converter power part;
- supply **V3** and **W3** to the power excitation part;
- supply **F1** and **F2** to the motor wound field;
- supply **A1** and **B2** to the motor armature.

Electrical circuit of the power block is given in **figure 9**.

Electrical circuit of power plate with pulse transformers and the channel of armature voltage measuring is given in **figure 10**. Places of the elements and the terminals on power plate are given in **figure 11**.

Electrical circuit of plate with channel for field current measuring is given in **figure 12**. The transformers of synchronization and supply of the control block are there, too. Places of the elements and terminals on the plate are given on the **figure 13**.

5.5.1 Converter controlling block supply

Three-phase mains voltage, on the input of the commutating choke **CH1**, is connected to terminals **U1** (X7.3), **V1** (X7.4) and **W1** (X7.5) for supply and synchronizing the converter controlling block.

5.5.2 Converter power part supply

The three-phase voltage from the output of the commutating choke **CH1** is connected to terminals **U2**, **V2** and **W2** to supply the converter power rectifier.

The ground is switched on to the terminals **N**(X7.1, 7.2).

5.5.3 Wound field power part supply

In **figure 16** is given a variant of the power part of the wound field supply by the transformer **TF1**. The voltage from the secondary coil of the wound field transformer **TF1** is switched on to the terminals **V3** (X7.6) and **W3** (X7.7) to supply the field rectifier.

Primary coil of the wound field transformer **TF1** must be connected to phases **L2** and **L3** of the power supply mains. If it is not observed the wound field synchronization will be wrong.

In **figure 17** is given a variant when the power part of the wound field is connected by a separated choke **CH2** directly to phases **L2** and **L3** of the power supply mains. If it is not observed the wound field synchronization will be wrong.

5.5.4 Motor wound field supply

The motor wound field is connected to terminals **F1** (X7.8) and **F2** (X7.9) of the power interface **X7** of the converters.

5.5.5 Motor armature supply

For converters type 4025, 4030, 4040, 4050 and 4060 the motor armature is connected to terminals **A1** and **B2**.

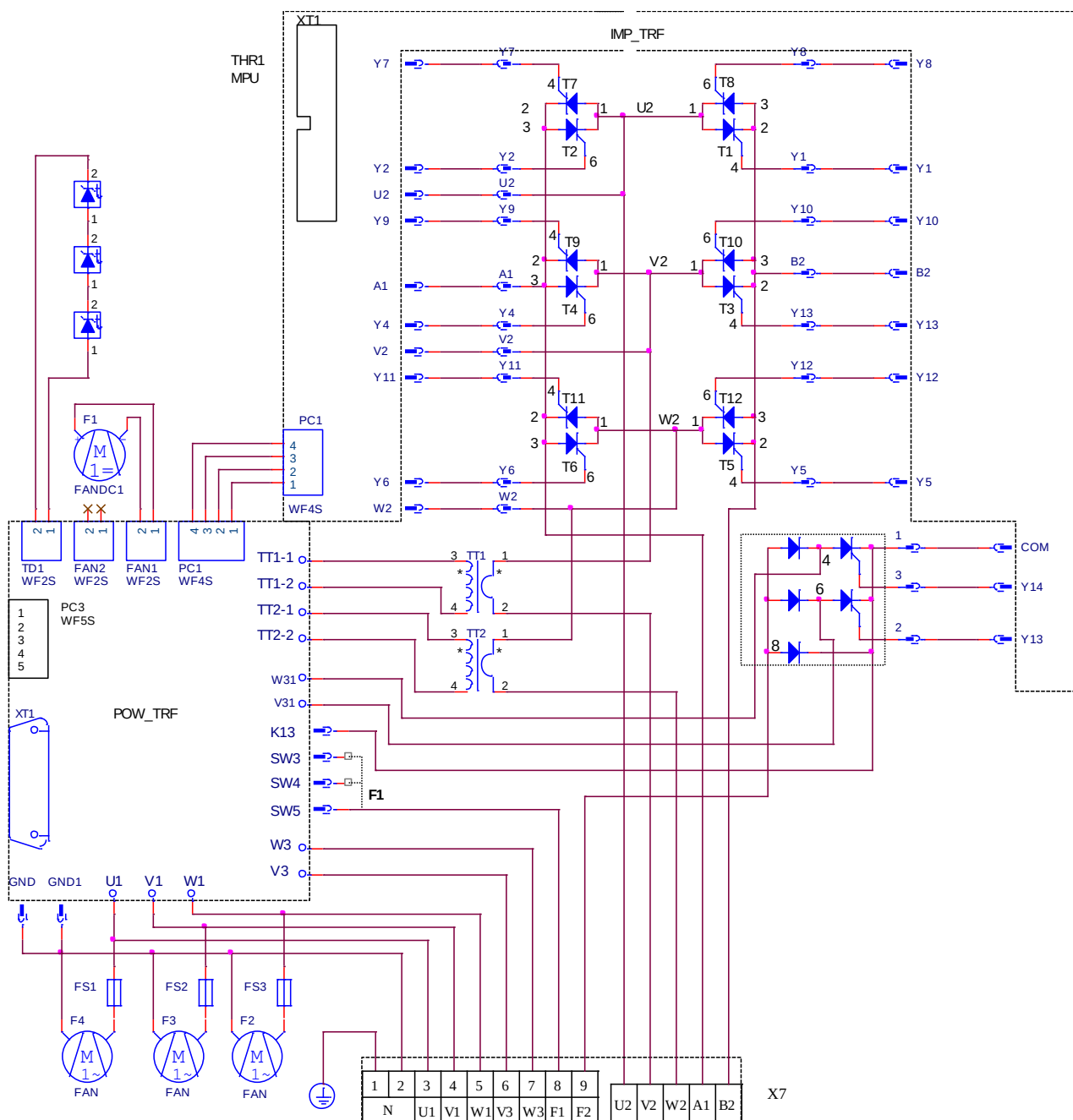


Figure 9 Electrical circuit of converter power block

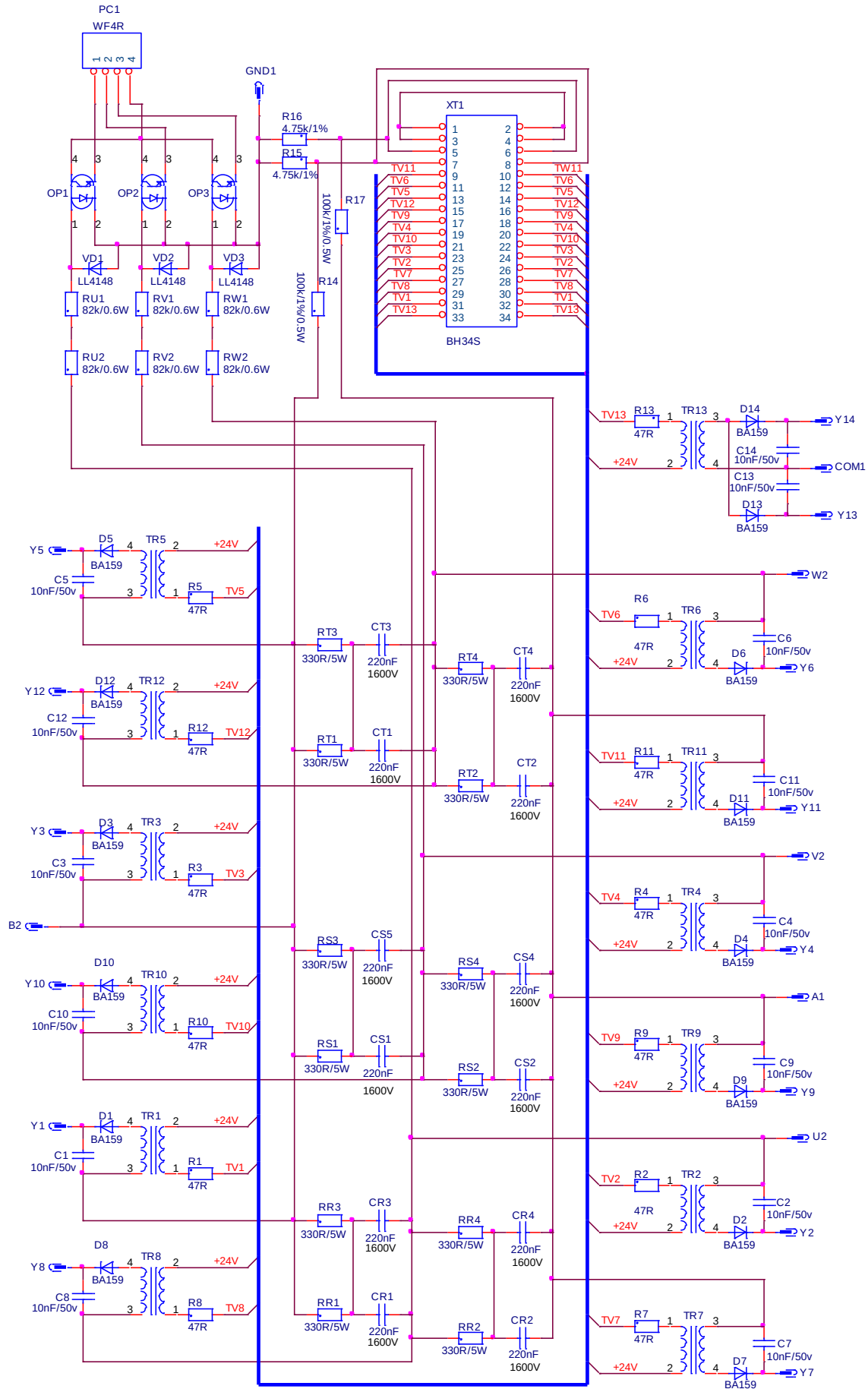


Figure 10 Electrical circuit of converter power PCB

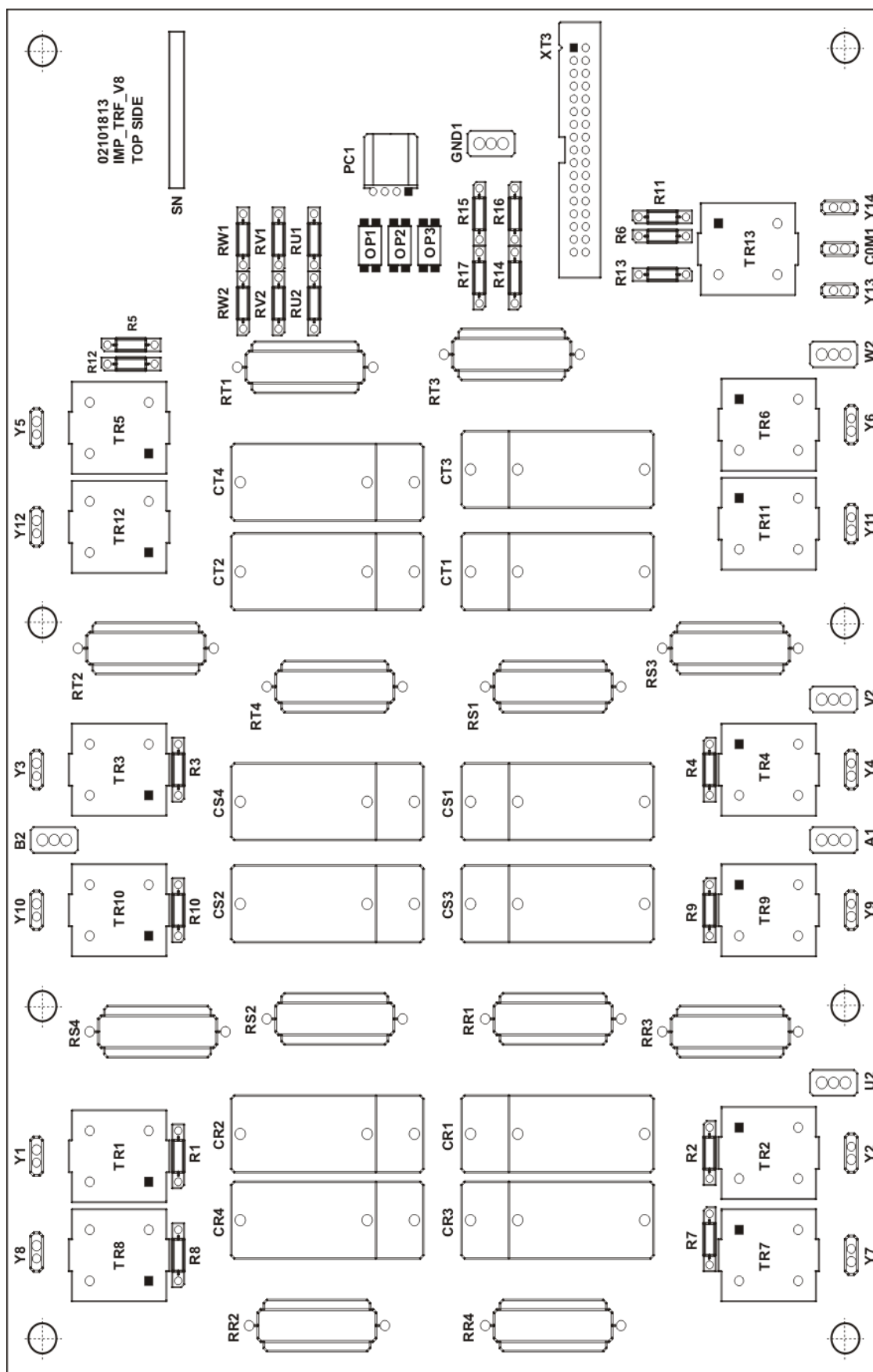


Figure 11 Places of power PCB elements and terminals

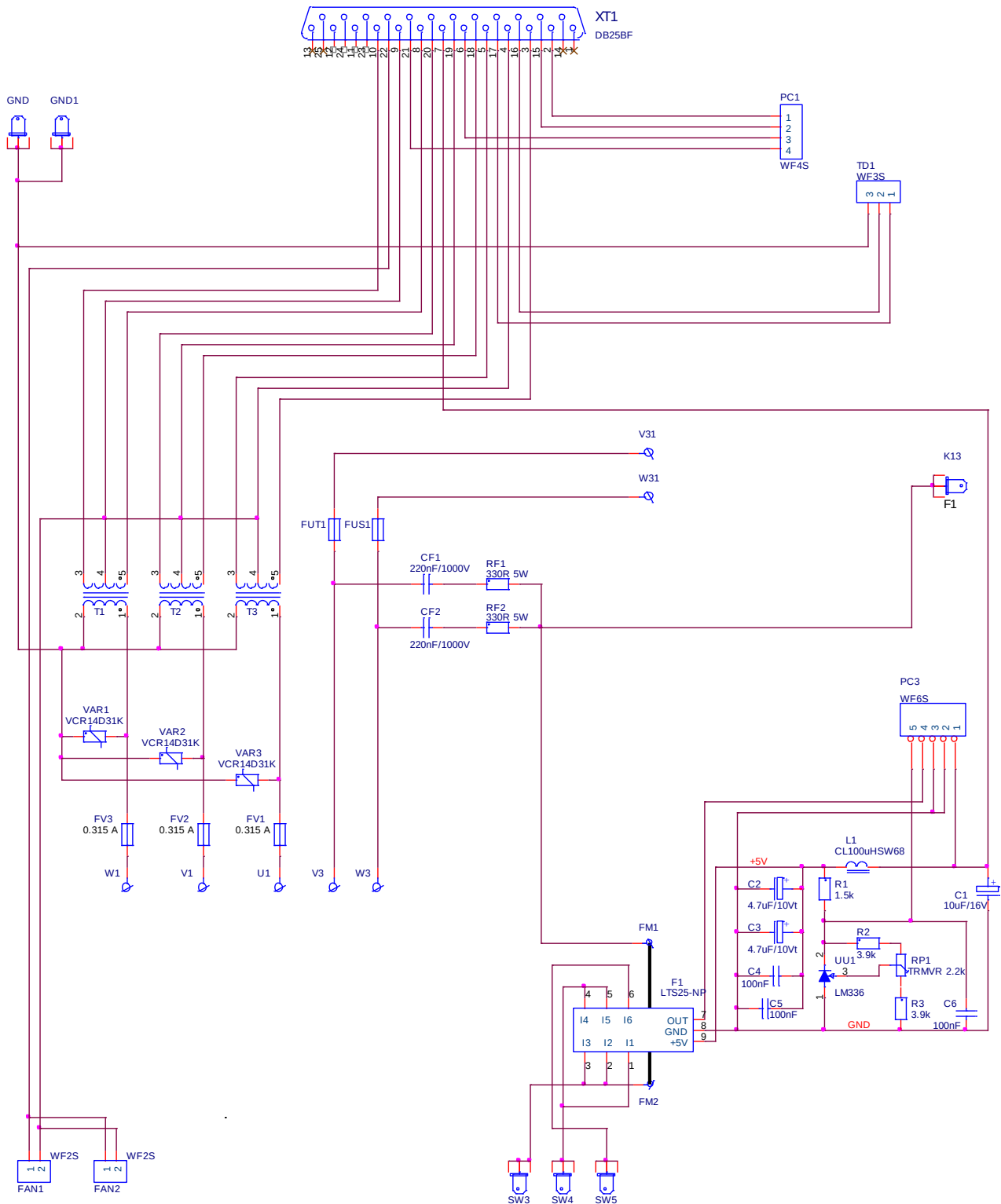


Figure 12 Electrical circuit of the PCB with the channel of field current measuring

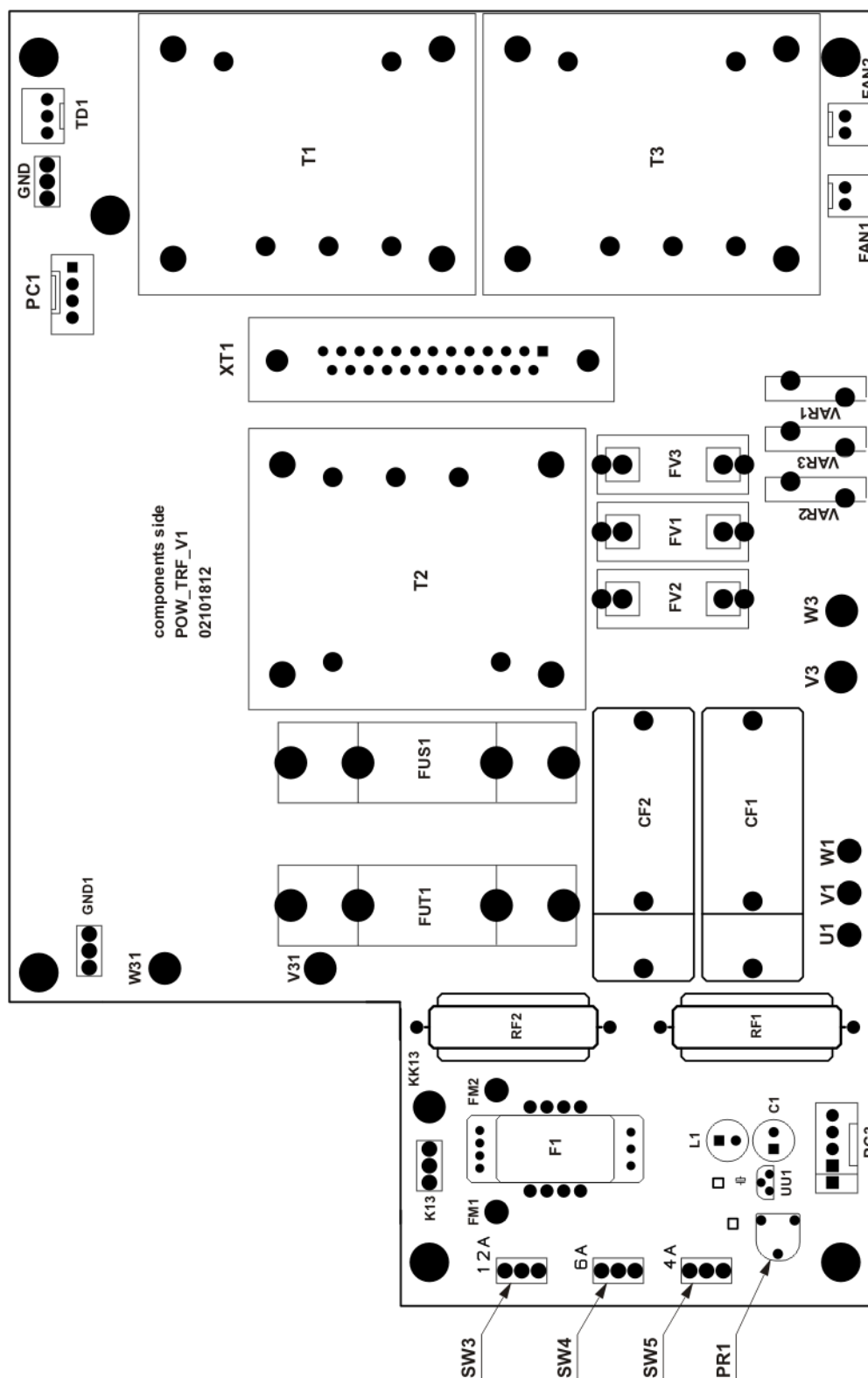


Figure 13 Places of the elements and terminals on the PCB

5.6 Converter status indications

At upper part of the face panel are placed 8 LEDs, which indicate the converter moment status. When any of them lights it means normal work mode or there is an emergency mode.

LED indications of converter status are as follows:

- **in normal work mode**

RD – converter is ready to work;

ON – converter work is enabled;

- **in emergency work mode**

FL – emergency mode. Current in field coil does not respond to the given ranged values;

TG – emergency mode. Wrong connection, short circuit or disconnection in tachogenerator feedback circuit;

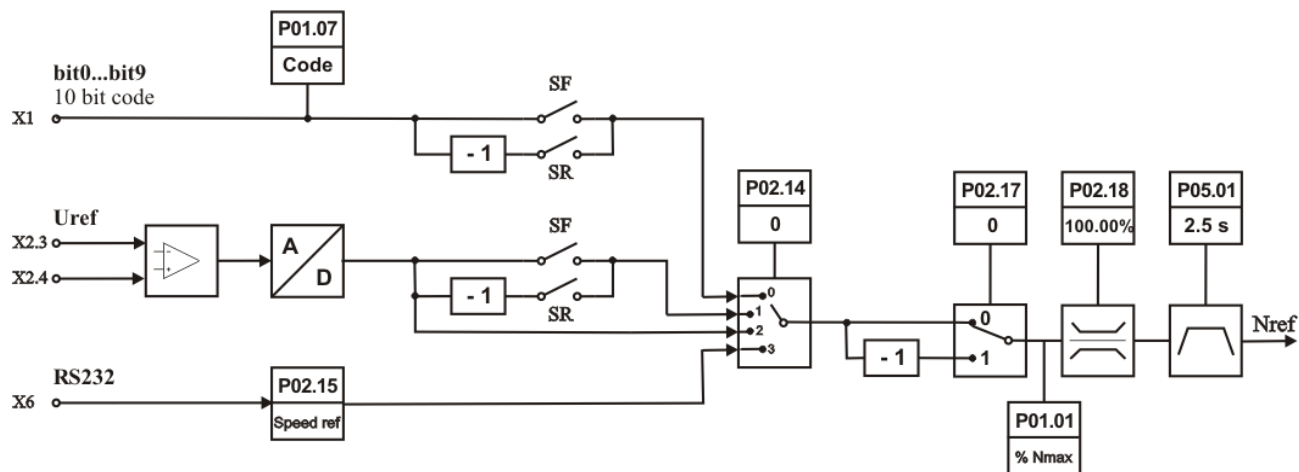
OC – emergency mode. Current in motor armature is over given ranged value or there is a short circuit in the converter power rectifier;

OS – emergency mode. Overspeed of maximum given rotating speed;

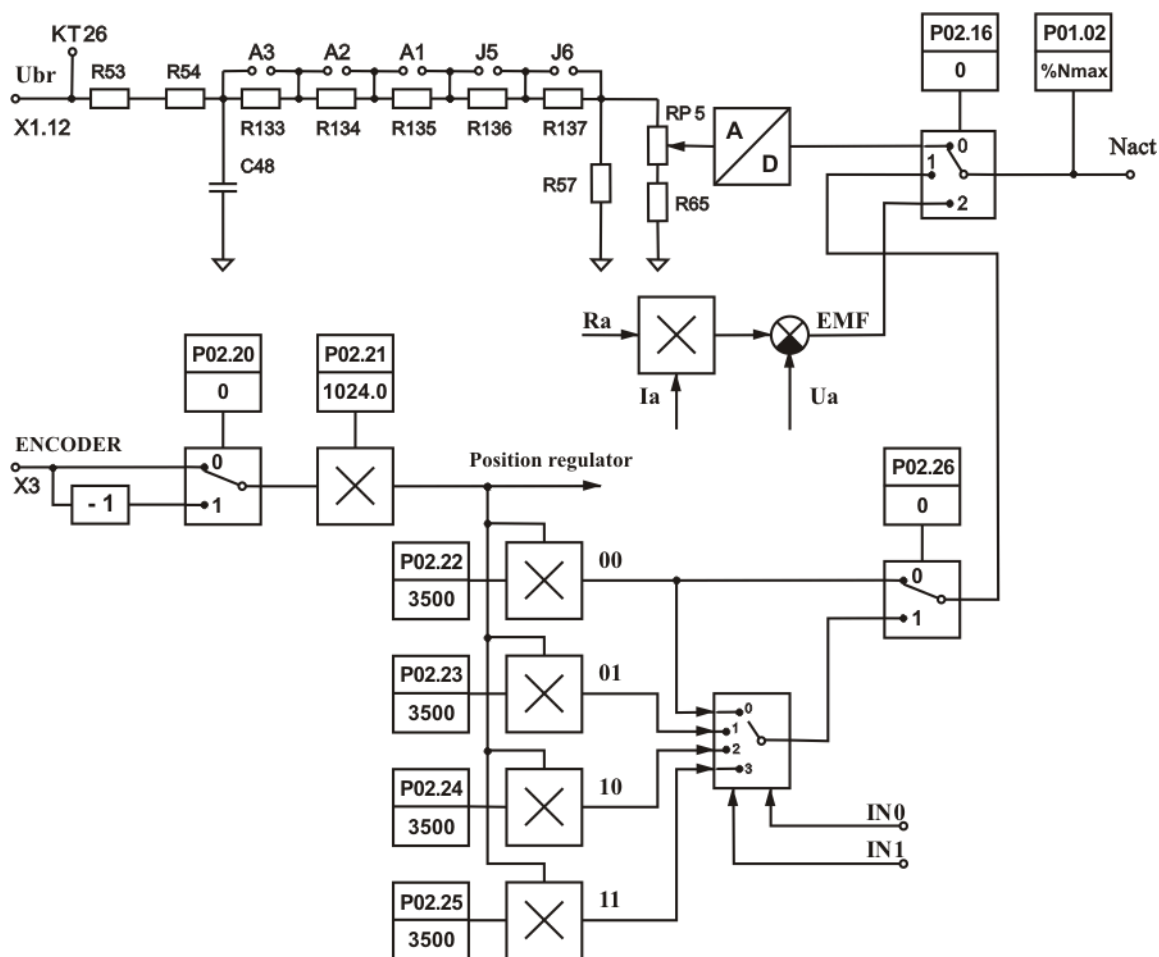
OL – emergency mode. The protection I^2t by overloaded of the motor or protection OH by overheated of the converter power block;

PF – emergency mode. Disconnection or bad connection of any power voltage phase. Bad ground of the converter.

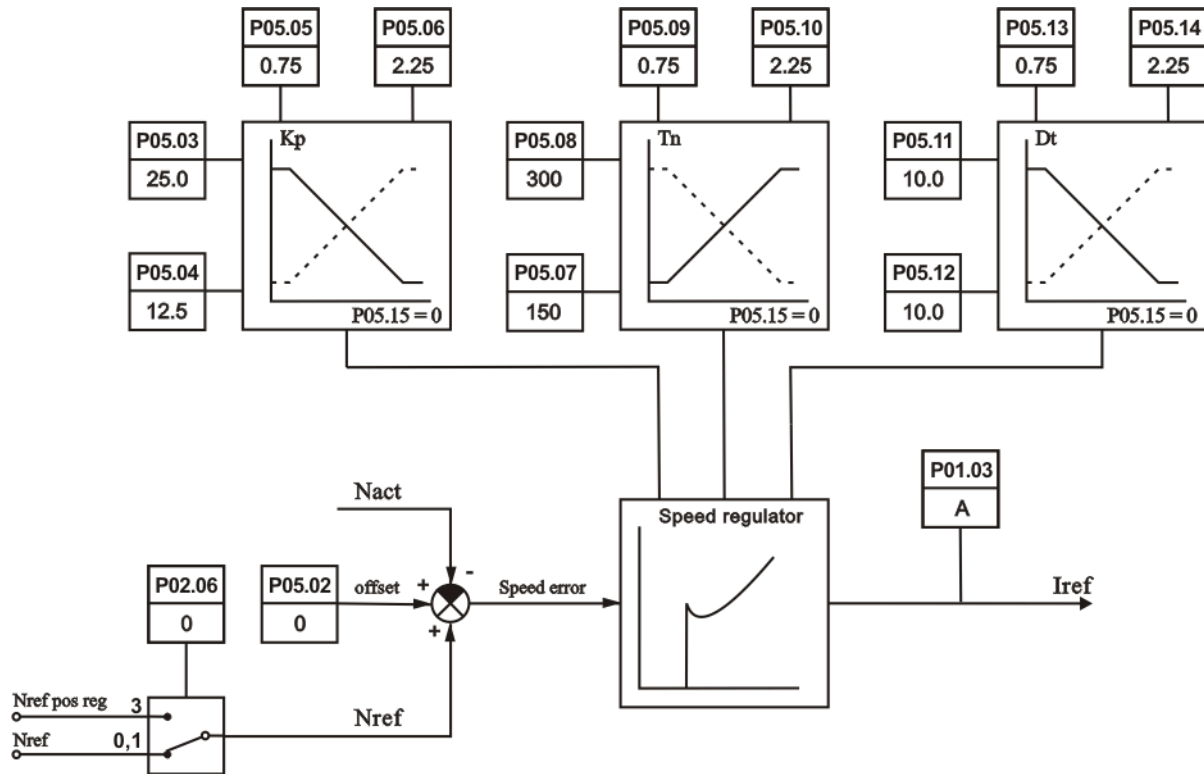
Protections and their action are described in detail in **p. 6.4.3** and **6.5**.



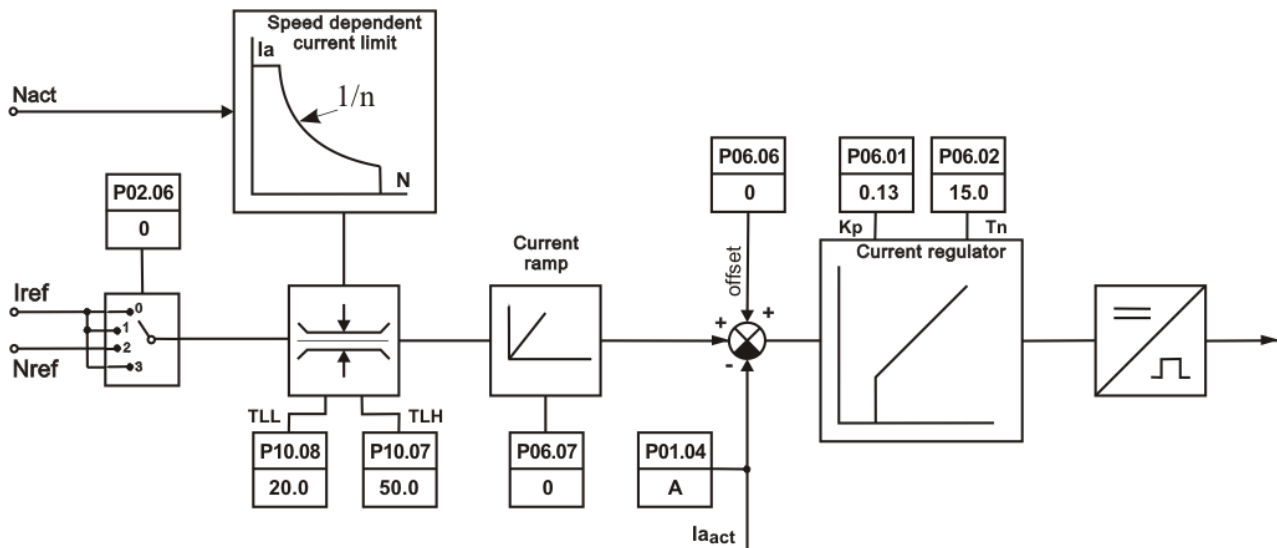
A Speed reference



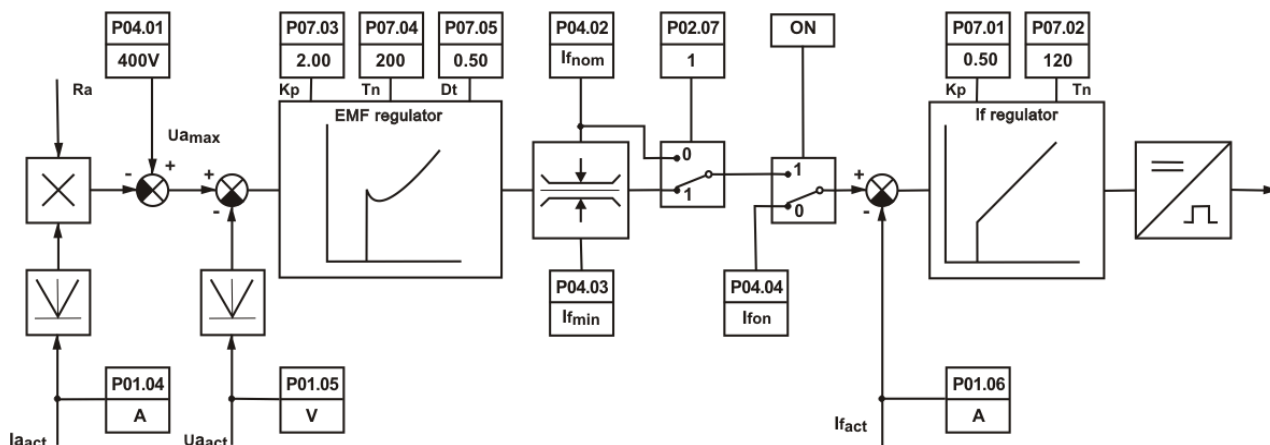
B Speed feedback



C Speed regulator



D Regulator of armature current



E Regulators of EMF and of the field current

Figure 14 Converter functional circuit

6. Converter adjustment

Adjustment is made through series interface **X6** by special terminal or personal computer.

ATTENTION!

Switching ON and OFF of the special terminal or personal computer to series interface X6 must be made only when converter power supply is OFF.

6.1 Work with special terminal or personal computer

By terminal in the device EPROM are set parameters, defining the work of the different functional blocks, motor parameters, limits in which protections and indications, giving information of converter status, activate. When the converter works, on terminal indication can be led the meaning of all parameters, which indicate motor and converter work, and together with LED indication placed on upper part of the face panel will give the whole picture of their status constantly.

When power supply is switched on, if there is not any error, on the terminal display is appeared a message **P01 Monitoring**, which points the chosen parameter group. Choice of a parameter group or a parameter also changing its meaning is made by the keys with signs:

ESC UP DOWN ENTER or signs **ESC** ↑ ↓ ↵

By keys **UP** and **DOWN** is increased and decreased number of the parameter or the group of parameters. After pressing the key **ENTER** on the terminal display is pointed the meaning of the chosen parameter, and its changing is made the same manner as its number. Chosen meaning of the parameter is set in the memory by the key **ENTER**.

Returning in the choosing a parameter mode is made by the key **ESC**. In case when meaning of a parameter is changed, but the key **ENTER** is not pressed, and the key **ESC** is pressed, the changing is not set. During changing the meaning of a parameter, keeping keys **UP** or **DOWN** for time, when there are changing more than fifty discretes of a decimal order, it starts changing the next order at senior. Releasing the key cancels this mode.

By keys **UP** and **DOWN** first choose the desired parameter group, after that by key **ENTER** enter the parameter group and also by keys **UP** and **DOWN** choose the needed parameter, by key **ENTER** enter parameter editing mode. Changing the parameter meaning is performed by keys **UP** and **DOWN** too, after that this meaning is set by the key **ENTER**. If the set meaning of the parameter is out of the limits, set meaning is limited by them.

To come back into parameter choice mode is used the key **ESC**, and by **UP** and **DOWN** choose the needed parameter. If this parameter is from other group press the key **ESC** secondary and come back to choice parameter group menu.

Keep work with terminal software for personal computer (for example TERM95.exe from the packet NORTON COMMANDER). Series interface (COM1 or COM2 on the computer) is adjusted to 9600bps, 8N1, terminal emulsion - ANSI. It is used the following keys:

- “**ESCAPE**” or “**o**” – function **ESCAPE**;
- “**ENTER**” or “**e**” – function **ENTER**;
- “**u**” – function **UP**;
- “**d**” – function **DOWN**;
- “**0 ÷ 9**” – discrete inserting parameter meaning;
- “ - ” – inverting meaning of the insert parameter.

When a parameter is chosen its number is displayed on the first line and a text which is given in third column of **table 8**, on the second line – parameter meaning. Changing of chosen parameter is made as it is pointed above.

Notes:

1. If after pressing the key **ENTER**, the new parameter value is not set, check if this parameter is accessible in that mode;
2. If the parameter value can not be changed more than a value check if it is connected with other parameters or the limit of its change is approached;
3. In case there are parameters connecting each other it is necessary first to change these from which others depend on.

6.2 Functional converter circuit

The functional converter circuit with adjusting and monitoring parameters is given in **figure 14**.

6.3 Converter parameteres

Parameters are grouped into twelve groups:

Group 01 – monitoring parameters

They display the value of the inner variables, controlling signals and signals to and from the motor. In this group are wound field parameters, armature current, rotating speed, armature voltage, digital inputs and outputs status, and accumulating protection errors. Values of these parameters are not set, they are only monitored;

Group 02 – converter parameters

They define converter working modes, feedback choice, type of the speed reference, rotating direction, encoder choice, and all general technical features of a power block realization.

Group 03 – protection parameters

The protection parameters define control variable limits out of which the protections activate.

Group 04 – motor parameters

By motor parameters it is set its general technical features. In this group are rated and maximum armature current, rated armature voltage, rated and minimal wound field current and dynamic current limiting of armature current.

Group 05 – Speed regulator parameters

By these parameters it is defined the coefficients of amplification, constant and parameters of speed regulator adaptation, and rampgenerator features.

Group 06 – armature current regulator parameters

Parameters in this group define the coefficient of amplification, and constant of armature current regulator and they regulate the amplitudes of the current pulses in each phase.

Group 07 – parameters of regulators of EMF and wound field current.

The parameters in this group define the coefficient of amplification and constant of EMF regulators and wound field current.

Group 08 – parameter of orientation stopping.

The parameters in this group define the input of position reference, correction of given position, position displacing, the coefficient of amplification of the position regulator, and point the error when it is performed orientation stopping.

Group 09 – digital inputs parameters

By parameters in this group it is defined the functions of the converter digital inputs and their active logical status;

Group 10 – digital output parameters

The parameters in this group define the functions and active logical status of digital outputs and variables for analog outputs;

Group 11 – terminal parameters

The parameters in this group define terminal working language and the time of indication refreshing.

Group 12 – error history

In **table 8** is given the list of parameters, their signs, and limits of their variations.

№	Parameter name	Text	Variation limits	Measure
Group 01 – watching parameters				
P01.01	Current value of speed reference	Speed reference	-	% N _{MAX}
P01.02	Current value of actual speed	Speed actual	-	% N _{MAX}
P01.03	Current value of armature current reference	Curr arm ref	-	A
P01.04	Current value of actual armature current	Curr arm actual	-	A
P01.05	Current value of armature voltage	Arm voltage act	-	V
P01.06	Current value of wound field current	Field curr act	-	A
P01.07	Digital inputs status IN1-IN10	Board dinp 1-10	-	code
P01.08	Digital inputs status IN11-IN18	Board dinp 11-18	-	code
P01.09	Reserved	RESERVED	-	-
P01.10	Digital outputs status	Board digit out	-	code
P01.11	Reserved	RESERVED	-	-
P01.12	Test of speed feedback	Test tacho fluct	-	% Ubr
P01.13	Current value of mains frequency	Line frequency	-	Hz
P01.14	Current maximum deviation in synchronization	Max synchro dev	-	μs
P01.15	Maximum number of recorded synchronization breaks	Max synchr break	-	-
P01.16	Maximum number of recorded power supply breaks	Max power break	-	-
P01.17	Power thyristors status	Status thyr	-	code
P01.18	Current value of encoder pulses	Act enc puls num	-	imp
Group 02 – converter parameters				
P02.01	Version of converter software	Software version	-	-
P02.02	Password of access	User password	11	-
P02.03	Restore of default values	Default load	0, 1	-
P02.04	Image of user's parameters	Write param img	0,1	-
P02.05	Reading user's parameters	Read param image	0,1	-
P02.06	Converter working mode	Mode control	-1,0, 1,2	-
P02.07	Work with weaken field	Field weakening	0, 1,2	-
P02.08	Scaling the converter nominal current Idrv_{NOM}	Curr arm nominal	5.0 ÷ 500.0	A
P02.09	Converter power supply	Power supply	100÷440	V
P02.10	Range of excitation current sensor	If sensor scale	1.5A÷20.0A	-
P02.11	Type of field current sensor	If sensor type	6A/15A/25A	-
P02.12	Armature current sensor - calculating R65, R66, R67	R65,66,67 calc		Ohm
P02.13	Mode “ emergency stop”	Emergency stop	0, 1, 2	-
P02.14	Choice of the speed reference source	User source ref	0, 1, 2, 3	-
P02.15	Inner speed reference	Source of ref	-100.00÷100.00	% N _{MAX}
P02.16	Type of the speed feedback	User feedback	0, 1, 2	-
P02.17	Changing the speed reference sign	Sign vel ref	0, 1	-
P02.18	Limitation maximum value of speed reference	Limit vel ref	1.00 ÷ 100.00	% N _{MAX}
P02.19	Changing the sign of speed feedback with tachogenerator	Sign tacho fdbck	0,1	-
P02.20	Changing the sign of speed feedback with encoder	Sign enc fdbck	0,1	-
P02.21	Encoder pulse number	Encoder puls num	100.0 ÷ 2500.0	puls/rev.
P02.22	First maximum speed	Enc speed max 1	100 ÷ 10 000	min ⁻¹
P02.23	Second maximum speed	Enc speed max 2	100 ÷ 10 000	min ⁻¹
P02.24	Third maximum speed	Enc speed max 3	100 ÷ 10 000	min ⁻¹
P02.25	Fourth maximum speed	Enc speed max 4	100 ÷ 10 000	min ⁻¹
P02.26	Enable changing at maximum speed	Change speed	0,1	-
P02.27	Source of armature circuit resistance	Ra source	0,1	-
Group 03 – protection parameters				
P03.01	Admissible break number in synchronization - protection SPF	Thr synchr break	5 ÷ 50	-
P03.02	Maximum recording break number in synchronization -	Max synchr break	-	-

	protection SPF			
P03.03	Maximum admissible deviation in synchronization - protection SPF	Thr synchro dev	100 ÷ 800	μs
P03.04	Current maximum deviation in synchronization - protection SPF	Max synchro dev	-	μs
P03.05	Admissible break number in power mains - protection HPF	Thr power break	5 ÷ 50	-
P03.06	Maximum recording break number in power supply mains - protection HPF	Max power break	-	-
P03.07	Working mode of protection HPF	Enable HPF	0, 1	-
P03.08	Activating time of protection OLF (I^2t) - motor overloaded	Threshold OLF	0.1 ÷ 100.0	s
P03.09	Working mode of protection OHF	Enable OHF	0, 1	-
P03.10	Limited admissible speed N_{LIM} – protection SOS	Threshold SOS	100.0÷110.0	% N_{MAX}
P03.11	Threshold current I_{drvLIM} of the converter - protection SOC	Threshold SOC	105.0 ÷ 125.0	% I_{aMAX}
P03.12	Armature voltage when protection STG activates	Thresh U_a STG	40.0÷80.0	% U_{aMAX}
P03.13	Maximum wound field current I_{FLMAX} – protection SFL	Thr prot FL max	> P04.02	A
P03.14	Minimum wound field current I_{FLMIN} – protection SFL	Thr prot FL min	≤ P04.04	A
P03.15	Limited error of tracking – protection OTE	Limit track err	10÷200 000	imp
P03.16	Protection OTE working mode	Enable OTE	0,1	-
P03.17	Limit armature voltage – protection OVM	Threshold OVM	105.0÷120.0	% U_{aMAX}
P03.18	Time of stabilization of field current – protection FWF	Wait field	2.0÷20.0	s
P03.19	Protection OLF working mode	EnableOLF	0,1	-
Group 04 – motor parameters				
P04.01	Maximum armature voltage U_{aMAX}	U_a max motor	100 ÷ 450	V
P04.02	Rated current of wound field I_{FNOM}	If rated motor	≥P04.05÷P02.10	A
P04.03	Minimum wound field working current I_{FMIN} in 2 zone	If min motor 2z	≥P04.04≤P04.02	A
P04.04	Minimum wound field working current I_{FMIN} in 3 zone	If min motor 3z	≥P03.14≤P04.04	
P04.05	Wound field current I_{FON} when control signal ON is switched off	If without ON	≥P03.14≤P04.02	A
P04.06	Rated motor speed in the table	N rated motor	100 ÷ P04.07	min ⁻¹
P04.07	Maximum motor speed in the table	N max motor	100÷10 000	min ⁻¹
P04.08	Real maximum motor speed	N max motor real	100÷P04.07	min ⁻¹
P04.09	Maximum armature current I_{aMAX} at p.1	I_a max of p.1	200.00÷P04.10	% I_{aNOM}
P04.10	Maximum armature current I_{aMAX} at p. 2	I_a max of p.2	P04.09÷P04.11	% I_{aNOM}
P04.11	Maximum armature current I_{aMAX} at p. 3	I_a max of p.3	P04.10÷20.00	% I_{aNOM}
Group 05 – speed regulator parameters				
P05.01	Rampgenerator time	Ramp time speed	0.0 ÷ 20.0	s
P05.02	Offset of speed reference	Speed offset	-1024 ÷ 1024	
P05.03	Coefficient of amplification of the speed regulator Kp1	Pgain sp reg Kp1	0.1 ÷ 100.0	-
P05.04	Coefficient of amplification of the speed regulator Kp2	Pgain sp reg Kp2	0.1 ÷ 100.0	-
P05.05	Threshold of working of the coefficient of amplification Kp1	Threshold Kp1	0.00 ÷ P05.06	%
P05.06	Threshold of working of the coefficient of amplification Kp2	Threshold Kp2	P05.05÷100.00	%
P05.07	Time constant of the speed regulator Tn1	Icomp sp reg Tn1	20 ÷ 2000	ms
P05.08	Time constant of the speed regulator Tn2	Icomp sp reg Tn2	20 ÷ 2000	ms
P05.09	Threshold of working of the time constant Tn1	Threshold Tn1	0.10 ÷ P05.10	%
P05.10	Threshold of working of the time constant Tn2	Threshold Tn2	P05.09÷100.00	%
P05.11	Differential component Dt1	Dcomp sp reg Dt1	0.0 ÷ 100.0	
P05.12	Differential component Dt2	Dcomp sp reg Dt2	0.0 ÷ 100.0	
P05.13	Working threshold of the differential component Dt1	Threshold Dt1	0.10 ÷ P05.14	%
P05.14	Working threshold of the differential component Dt2	Threshold Dt2	P05.13 ÷ 100.00	%
Group 06 – armature current regulator parameters				

P06.01	Coefficient of amplification of the armature current regulator	P gain curr reg	0.01 ÷ 2.00	-
P06.02	Time constant of armature current regulator	Icomp curr reg	10.0 ÷ 200.0	ms
P06.03	Adjusting the phase L1 current amplitude	Curr peak L1	-512 ÷ 512	discretes
P06.04	Adjusting the phase L2 current amplitude	Curr peak L2	-512 ÷ 512	disrtetes
P06.05	Adjusting the phase L3 current amplitude	Curr peak L3	-512 ÷ 512	discretes
P06.06	Offset of armature current	Offset current	-50÷50% P02.08	A
P06.07	Time of the armature current ranpgenerator	Ramp time curr	0 ÷ 500	ms
Group 07 – EMF regulators and wound field current parameters				
P07.01	Coefficient of amplification of the wound field current regulator	Pgain field reg	0.01 ÷ 10.00	-
P07.02	Time constant of the wound field current regulator	Icomp fild reg	10 ÷ 2000	ms
P07.03	Coefficient of amplification of the EMF regulator	P gain EMF reg	0.01 ÷ 10.00	-
P07.04	Time constant of the EMF regulator	I comp EMF reg	10 ÷ 2000	ms
P07.05	Differential component of EMF regulator	Dcomp EMF reg	0.01÷ 10.00	
Group 08 – orientation stopping parameters				
P08.01	Acceleration of rising 1	Rise accel 1	1÷ 20000	-
P08.02	Acceleration of stopping 1	Fall accel 1	1÷ 20000	-
P08.03	Acceleration of rising 2	Rise accel 2	1÷ 20000	-
P08.04	Acceleration of stopping 2	Fall accel 2	1÷ 20000	-
P08.05	Coefficient of amplification K1 of the position regulator	Pgain pos reg Kp	0.05÷200.00	
P08.06	Enable of the tracking position mode	Ena tracking pos	0,1	
P08.07	Current error of tracking	Tracking error		imp
P08.08	Recorded maximum tracking error	Max track error		imp
P08.09	Tuning of the tracking error	Tracking tuning	0.00÷200.00	
P08.10	Position window	Position window	1÷20000	imp
P08.11	Time for fixing in position	Pos mon time	0÷10000	ms
P08.12	Current error of position	Curr pos error	-	imp
P08.13	Zero position	Zero position	≤P02.21x4	imp
P08.14	Speed of fixing in zero position	Zero pos vel	1÷2000	min ⁻¹
P08.15	Direction of speed at searching zero position	Sign search vel	0,1,2	
P08.16	Source of speed at searching zero position	Src zero pos vel	0,1	
P08.17	Speed of searching zero position	Search veocity	1÷1000	min ⁻¹
Group 09 – input parameters				
P09.01	Type of digital input IN1	Type brd inp 1	0÷40	-
P09.02	Invert logical level of digital input IN1	Logic brd inp 1	0,1	-
P09.03	Type of digital input IN2	Type brd inp 2	0÷40	-
P09.04	Invert logical level of digital input IN2	Logic brd inp 2	0,1	-
P09.05	Type of digital input IN3	Type brd inp 3	0÷40	-
P09.06	Invert logical level of digital input IN3	Logic brd inp 3	0,1	-
P09.07	Type of digital input IN4	Type brd inp 4	0÷40	-
P09.08	Invert logical level of digital input IN4	Logic brd inp 4	0,1	-
P09.09	Type of digital input IN5	Type brd inp 5	0÷40	-
P09.10	Invert logical level of digital input IN5	Logic brd inp 5	0,1	-
P09.11	Type of digital input IN6	Type brd inp 6	0÷40	-
P09.12	Invert logical level of digital input IN6	Logic brd inp 6	0,1	-
P09.13	Type of digital input IN7	Type brd inp 7	0÷40	-
P09.14	Invert logical level of digital input IN7	Logic brd inp 7	0,1	-
P09.15	Type of digital input IN8	Type brd inp 8	0÷40	-
P09.16	Invert logical level of digital input IN8	Logic brd inp 8	0,1	-
P09.17	Type of digital input IN9	Type brd inp 9	0÷40	-
P09.18	Invert logical level of digital input IN9	Logic brd inp 9	0,1	-
P09.19	Type of digital input IN10	Type brd inp 10	0÷40	-

P09.20	Invert logical level of digital input IN10	Logic brd	0,1	-
		10 10		
P09.21	Type of digital input IN11	Type brd inp 11	0÷40	-
P09.22	Invert logical level of digital input IN11	Logic brd inp	0,1	-
P09.23	Type of digital input IN12	Type brd inp 12	0÷40	-
P09.24	Invert logical level of digital input IN12	Logic brd inp	0,1	-
P09.25	Type of digital input IN13	Type brd inp 13	0÷40	-
P09.26	Invert logical level of digital input IN13	Logic brd inp	0,1	-
P09.27	Type of digital input IN14	Type brd inp 14	0÷40	-
P09.28	Invert logical level of digital input IN14	Logic brd inp	0,1	-
P09.29	Type of digital input IN15	Type brd inp 15	0÷40	-
P09.30	Invert logical level of digital input IN15	Logic brd inp	0,1	-
P09.31	Type of digital input IN16	Type brd inp 16	0÷40	-
P09.32	Invert logical level of digital input IN16	Logic brd inp	0,1	-
P09.33	Type of digital input IN17	Type brd inp 17	0÷40	-
P09.34	Invert logical level of digital input IN17	Logic brd inp	0,1	-
P09.35	Type of digital input IN18	Type brd inp 18	0÷40	-
P09.36	Invert logical level of digital input IN18	Logic brd inp	0,1	-
Group 10 – output parameters				
P10.01	Speed threshold N_{ZS} , under which ZS activates	Thresh out ZS	0.01 ÷ 15.00	% N_{MAX}
P10.02	Time to confirm the change of ZS	Change thr ZS	1÷1000	ms
P10.03	Speed threshold N_{SA} , above which SA activates	Thresh out SA	1.00 ÷ 30.0	% N_{REF}
P10.04	Time to confirm the change of SA	Change thr SA	1÷1000	ms
P10.05	Speed at which SA starts working	Level SA	0.01 ÷ 15.00	% N_{MAX}
P10.06	Time to confirm the change of INPOS	Change thr INPOS	1÷1000	ms
P10.07	Maximum armature current I_{aTLH} at control signal TLH	Level of TLH	10.0 ÷ 100.0	% I_{aNOM}
P10.08	Maximum armature current I_{aTLL} at control signal TLL	Level of TLL	1.0 ÷ 100.0	% I_{aNOM}
P10.09	Type of relay output OUT1	Type brd out 1	0÷10	-
P10.10	Invert the output logical level OUT1	Logic brd out 1	0, 1	-
P10.11	Type of relay output OUT2	Type brd out 2	0÷10	-
P10.12	Invert the output logical level OUT2	Logic brd out 2	0, 1	-
P10.13	Type of relay output OUT3	Type brd out 3	0÷10	-
P10.14	Invert the output logical level OUT3	Logic brd out 3	0, 1	-
P10.15	Type of relay output OUT4	Type brd out 4	0÷10	-
P10.16	Invert the output logical level OUT4	Logic brd out 4	0, 1	-
P10.17	Type of relay output OUT5	Type brd out 5	0÷10	-
P10.18	Invert the output logical level OUT5	Logic brd out 5	0, 1	-
P10.19	Select the variable of analog output AOUT1	Select var AOUT1	1 ÷ 12	-
P10.20	Select the variable of analog output AOUT2	Select var AOUT2	1 ÷ 12	-
P10.21	Range of analog output AOUT1	Range AOUT1	2.0 ÷ 10.0	V
P10.22	Range of analog output AOUT2	Range AOUT2	2.0 ÷ 10.0	V
Group 11 – terminal parameters				
P11.01	Selecting terminal language	Language	0, 1, 2	-
P11.02	Time for indication refreshing	Refresh rate	1 ÷ 1000	ms
Group 12 – error history				
P12.01	Error 1	Error 1	-	-
P12.02	Error 2	Error 2	-	-
P12.03	Error 3	Error 3	-	-
P12.04	Error 4	Error 4	-	-
P12.05	Error 5	Error 5	-	-
P12.06	Error 6	Error 6	-	-
P12.07	Error 7	Error 7	-	-
P12.08	Error 8	Error 8	-	-
P12.09	Error 9	Error 9	-	-

P12.10	Error 10	Error 10	-	-
P12.11	Error 11	Error 11	-	-
P12.12	Error 12	Error 12	-	-
P12.13	Error 13	Error 13	-	-
P12.14	Error 14	Error 14	-	-
P12.15	Error 15	Error 15	-	-
P12.16	Error 16	Error 16	-	-
P12.17	Reset errors	Reset errors	0, 1	-

Table 8 Parameters list

Notes:

1. Parameters in dark fields can be changed only after the password is inserted and control signal **ON** is switched off. Parameters in white fields can be changed in all modes only after password is inserted;

2. Parameters from group **P01** values can be monitored without inserting the password;

3. For the sake of convenience parameters pointing accumulated errors of protections from group **P03** also enter in group **P01** of monitoring parameters.

6.4 Parameter description

6.4.1 Group 01 – parameters for variable monitoring

Parameters from **P01.01** to **P01.16** allow monitoring variable values, describing motor and converter work. These parameters are of access in all modes.

- Parameter **P01.01** – current value of speed reference. It is defined in percentage from the maximum speed N_{MAX} ;
- Parameter **P01.02** – current value of actual speed. It is defined in percentage from maximum speed N_{MAX} ;
- Parameter **P01.03** – current value of armature current reference in amperes;
- Parameter **P01.04** – current value of actual armature current in amperes;
- Parameter **P01.05** – current value of armature voltage in volts with sign;
- Parameter **P01.06** – current value of actual wound field current in amperes;
- Parameters **P01.07** – current value of digital inputs from **IN1** to **IN10**. The status of digital inputs is given in binary code. The correspondence between active digital inputs and respective order is given in **table 9**;

Input		LCD	Input		LCD
IN10	X1.33	1000000000	IN5	X1.17	0000010000
IN9	X1.15	0100000000	IN4	X1.36	0000001000
IN8	X1.34	0010000000	IN3	X1.18	0000000100
IN7	X1.16	0001000000	IN2	X1.37	0000000010
IN6	X1.35	0000100000	IN1	X1.19	0000000001

Table 9 Correspondence between indication order and digital inputs from **IN1** to **IN10** status

- Parameters **P01.08** – current status of the digital inputs from **IN11** to **IN18**. Digital inputs status is given in binary code. The correspondence between active digital inputs and corresponding order is given in **table 10**;

Input		LCD	Input		LCD
IN18	X1.25	10000000	IN14	X1.27	000001000
IN17	X1.7	01000000	IN13	X1.9	000000100
IN16	X1.26	00100000	IN12	X1.32	000000010
IN15	X1.8	00010000	IN11	X1.14	000000001

Table 10 Correspondence between indication orders and digital inputs from **IN11** to **IN18** status

- Parameter **P01.09** – reserved;
- Parameter **P01.10** – current status of digital outputs from **OUT1** to **OUT5**. Digital outputs status is given in binary code. The correspondence between active digital outputs and corresponding orders is given in **table 11**.

Output		LCD
OUT5	X1.2,20	10000
OUT4	X1.3,21	01000
OUT3	X1.4,22	00100
OUT2	X1.5,23	00010
OUT1	X1.6,24	00001

Table 11 Correspondence between indication orders and digital outputs status

- Parameter **P01.11** – reserved;
- Parameter **P01.12** – current value of the fluctuations of speed feedback voltage. Fluctuations are defined in percentage of the relation of the maximum value of voltage of the tachogenerator to its average value U_{br} in time interval 1s. When the tachogenerator is all right in stable mode, the parameter **P01.12** value must not be more than 2 %;
- Parameter **P01.13** – current value of the power mains frequency in hertz;
- Parameter **P01.14 (P03.04)** – maximum recorded time of deviation between waited and registered synchronization pulses. Each recorded time more than the value of parameter **P03.03**, is registered as a synchronization error and it is accumulated in the counter of protection **SPF**. By key **UP** indication is reset and it is started new registration of deviation. The value of parameter **P01.14** is not written in EEPROM. Parameter **P01.14** allows monitoring the quality of the power supply mains;
- Parameter **P01.15 (P03.02)** – maximum number recorded serial breaks in the synchronization. Checking for breaks in the synchronization starts at the moment switching on the converter. By key **UP** the indication is reset and it is started a new recording of the breaks. The value of the parameter **P01.15** is not written in EEPROM. If the number of the recorded breaks is more or equal to the value written in **P03.01**, protection **SPF** activates. Parameter **P01.15** allows monitoring the quality of the power supply mains;
- Parameter **P01.16 (P03.06)** – maximum number recorded serial breaks in power mains to its restoring. Checking for breaks in the power supply mains starts at the moment of switching on the converter. By key **UP** the indication is reset and it starts a new registering of the breaks. The meaning of the parameter **P01.16** is not written in EEPROM. If the number of the recorded breaks is more or equal to the meaning written in **P03.16**, protection **HPF** activates. Parameter **P01.16** allows watching the quality of the power supply mains;
- Parameter **P01.17** – working status of the power thyristors. When you enter this parameter on the terminal display are appeared two groups of six orders zeros each which correspond to the number of thyristors in groups from **T12** to **T1** from left to right. When all of the thyristors work, all orders in the group must display zero. Checking is made of the two rotating directions. If any of the orders is stable in **1** it means that the corresponding thyristor is not worked and it must be repaired the reason of that.
- Parameter **P01.18** – current value of encoder pulses. It is pointed the number of encoder pulses from zero to zero pulse. Number of the recorded pulses must correspond to the number of pulses in encoder table. If number of the recorded pulses is less then there are more than one zero pulse. During the checking must not change the rotating direction as in this case the checking will be incorrect. Function is not active during stopping in zero point.

6.4.2 Group 02 – converter parameters

- Parameter P02.01 – version of the converter software;
- Parameter P02.02 – password allowing parameter value changing. The password activates to switching off the power supply. When you insert **11** into parameter **P02.02**, the converter accepts the password and it displays on the terminal **1**- a message of password accepted;
- Parameter P02.03 – when you insert **1** into parameter **P02.03** it is restore in default of the value of all parameters. Parameter **P02.03** is of access for changing when password is inserted and control signal **ON** is switched off;
- Parameter P02.04 – image of user's parameters. When it is inserted **1** in parameter **P02.04**, a copy of user's parameters is written in EEPROM;
- Parameter P02.05 – restore user's parameters. When it is inserted **1** in parameter **P02.05** values of user's parameters are restored;
- Parameter P02.06 – converter working mode. Changing the parameter **P02.06** is not written into EEPROM. Parameter **P02.06** has four meanings:
 - **P02.06 = -1** – resistance of the armature circuit R_a is defined automatically. It is performed when parameters **P02.06 = -1** and **P02.27 = 1**. When control signal **ON** activates and field current is switched off for time of 10 s, 5 short current pulses are given to the armature circuit automatically, after that the armature circuit resistance is calculated and written;
 - **P02.06 = 0** – integral mode. This is a normal converter working mode. In integral mode current and speed regulators are switched on. When you switch on the converter parameter **P02.06** is always 0;
 - **P02.06 = 1** – proportional mode. In proportional mode current and speed regulators work only with proportional component with EMF feedback. Proportional mode is used at primary start and converter adjustment;
 - **P02.06 = 2** control by torque mode. In this mode speed regulator is switched off and the torque (armature current) is given directly. The maximum reference responds to the maximum motor torque.

Attention: If in control by torque mode the motor is without a load it will rotate with overspeed.

- Parameter P02.07 – converter working mode with motor weakening field. Parameter **P02.07** has three meanings:
 - **P02.07 = 0** – the motor works without weakening field only in the first zone. In this mode the work is enabled when parameter **P02.16 = [0, 1, 2]**. Device works with constant motor torque to approaching rated speed, given in parameter **P04.06**;
 - **P02.07 = 1** – the motor works with weakening field in the second zone. When the motor works with weakening field values of the parameter **P02.11 = [0, 1]** are enabled. Speed feedback EMF of motor when **P02.16 = 2** cannot ensure a normal work in the second zone. In the second zone motor armature voltage is constant, but the velocity is increased by decreasing wound field current. In this mode the device works with constant motor power from rated speed set in parameter **P04.06** and nominal field current from parameter **P04.02** to minimum field current in the second zone set in parameter **P04.03**;
 - **P02.07 = 2** – motor works with weakening field and decreasing of the power in the third zone. In this mode the device works with decreasing the motor power from minimum field current in the second zone **P04.03** to minimum field current in the third zone **P04.04**.
- Parameter P02.08 – scaling the converter nominal current I_{drv_NOM} . By parameter **P02.08** is scaled armature current outline, which permits all variables of the armature current to be measured in amperes. The inserting value of the parameter **P02.08** is not changed at restoring in default of the values by **P02.03**.

Converter rated current I_{drv_NOM} is defined by the power devices and the system of cooling the power block. For normal converter work the values of measured resistors **R65**, **R66**, and **R67** in

the secondary coils of current transformers circuit must correspond to the rated current of the power block. Places of the measured resistors **R65**, **R66**, and **R67** on the processor PCB is given on **fig.18**.

Nominal converter current **Idrv_{NOM}** and corresponding resistors **R65**, **R66**, and **R67** values are given in **P02.12** after inserting the **P02.08**.

Notes:

1. All resistor values are in ohms;
2. All resistors with resistance more than 20 Ω must be with power 0.25 W;
3. All resistors with resistance less than 20 Ω must be with power no less than 0.5 W.

ATTENTION!

Value of the parameter P02.08 must correspond to the motor nominal current and must not be more than the converter nominal current. If this desire is observed it is possible the converter power block is damaged.

If in the converter a new MPU plate is mounted, value of the measured resistors R65, R66, and R67 must correspond to converter nominal current, given in the motor name plate on its corpus.

- **Parameter P02.09** – converter power supply voltage. It is insert the converter linear power supply voltage in volts. For motors with armature voltage 220V or less it is permit operative power (U1, V1, W1) to be 3x380V, and power (U2, V2, W2) by a transformer 380/220V and then in parameter P02.09 is set real power supply voltage 220V. The only condition at this is the transformer not to make phase deviation i.e. its first and secondary coils must have the same circuit of switching on;
- **Parameter P02.10** – range of the sensor for the wound field current. Parameter **P02.10** has three meanings for each type sensor, chosen by parameter **P02.11**. Values of the parameter **P02.10** depending on the sensor type are given in **table 12**. Value of the parameter **P02.10** is not restored by default. Values of parameter **P02.10** for sensor 25A and corresponding connection of field channel to terminals **SW3**, **SW4**, and **SW5** on the power plate is given below:
 - **P02.10** = 6.7A – first range of the wound field current. The conductor with label **F1** is placed in terminal **SW5**.
 - **P02.10** = 10.0A – second range of the wound field current. The conductor with label **F1** is placed in the terminal **SW4**.
 - **P02.10** = 20.0A – third range of the wound field current. The conductor with label **F1** is placed in terminal **SW5**.
 Place of the terminals **SW3**, **SW4** and **SW5** on the power plate is given in **figure 13**;
- **Parameter P02.11** – type of the field current sensor. Standard type sensor used in convertors 4XXX has range 25A. Current sensors 6A and 15A are mounted in cases, when the motor field current has low values. The value of the parameter **P02.11** is not restored by default. Parameter **P02.11** has following values:
 - **P02.11** = 6A – maximum field current 4.7A;
 - **P02.11** = 15A – maximum field current 12.0A;
 - **P02.11** = 25A – maximum field current 20.0A.

	P02.10	P02.10	P02.10
P02.11 = 6A	1.5 A	2.4 A	4.7 A
P02.11 = 15A	4.0 A	6.0 A	12.0 A
P02.11 = 25A	6.5 A	10.0 A	20.0 A

Table 12: Ranges of field current depending on the sensor type

Notes:

1. It is not used the whole range of the current sensor, because that can break down the protection **SOF** work for overcurrent of maximum enable field current work;
 2. At adjusting it must be used possible lowest range for more effective using the analog digital converter.
- **Parameter P02.12** – calculating the value of the equivalent resistance of the measuring resistors **R65**, **R66**, and **R67** of armature current sensor. The resistors are in parallel connection.
 - **Parameter P02.13** – emergency stopping mode. Parameter **P02.13** can have the following three meanings:
 - **P02.13 = 0** – after switching off the control signal **ON**, the converter power rectifier is switched off and the motor stops floating.
 - **P02.13 = 1** – after switching off the control signal **ON**, the motor stops in time, given as a value of the parameter **P05.01** to zero speed **N_{ZS}**, given with the parameter **P10.01** and the output **ZS** activates. Converter power rectifier is switched off and the motor stops finally floating;
 - **P02.13 = 2** – after switching off the control signal **ON**, the motor stops maximum fast to zero speed **N_{ZS}** set in parameter **P10.01** and output **ZS** activates. The power rectifier is switched off and the motor stops finally floating.
 - **Parameter P02.14** – choice of the speed reference source. It has four meanings:
 - **P02.14 = 0** – speed reference with parallel code from digital inputs. In detail forming of the digital speed reference with parallel code is given in **p.5.1.1**. Rotating direction is chosen by control signals **SR** and **SF**. The reference is performed only when there is one of the control signals **SR** and **SF**. The reference is not performed when the two signals are available or absent at the same time;
 - **P02.14 = 1** – speed reference from analog input **U_{REF}** in range **0 ÷ +10V** or in range **0 ÷ -10V**. Rotating direction depends on the reference sign, too. Rotating direction is chosen by control signals **SR** and **SF**. The reference is performed only when one of the control signals **SR** and **SF** is available. The reference is not performed when the two control signals are available or absent at the same time;
 - **P02.14 = 2** – speed reference from analog input **U_{REF}** in range from **-10V** to **+10V**;
 - **P02.14 = 3** – speed reference by series interface **RS 232C**. In this case speed reference is defined by the value of the parameter **P02.15**.
 - **Parameter P02.15** – inner speed reference when the parameter **P02.14 = 3**. The value of the parameter **P02.15** is insert by the terminal. The value of the parameter **P02.15** is not written in EEPROM;
 - **Parameter P02.16** – choice the type of the speed feedback sensor. Parameter **P02.16** has three meanings:
 - **P02.16 = 0** – speed feedback with tachogenerator;
 - **P02.16 = 1** – speed feedback with encoder;
 - **P02.16 = 2** – speed feedback from the motor EMF.
 - **Parameter P02.17** – changing the speed reference sign. It can have two meanings:
 - **P02.17 = 0** – the reference sign is the same;
 - **P02.17 = 1** – the reference sign is inverted, independent on the reference source, chosen by parameter **P02.14**;
 - **Parameter P02.18** – limit reference at the maximum rotating speed. At this limit the speed feedback scale is the same but speeds more than the ones setting in parameter **P02.18** are not performed;
 - **Parameter P02.19** – changing the sign of the speed feedback with tachogenerator. It has two meaning:
 - **P02.19 = 0** – feedback sign is the same;

- **P02.19** = 1 – feedback sign is inverted.
- **Parameter P02.20** – changing the sign of the speed feedback with encoder. Parameter **P02.20** inverts the pulses order of the encoder phases. It has two meaning:
 - **P02.20** = 0 – feedback sign is the same;
 - **P02.20** = 1 – feedback sign is inverted.
- **Parameter P02.21** – encoder resolution. It is defined the encoder pulse number in one revolution;
- **Parameter P02.22** – first maximum spindle rotating speed at maximum motor rotating speed N_{MAX} . It is performed when control signals N_{max1} and N_{max2} are not active. When speed changing is forbidden at **P02.26** = 0 and at work with encoder in **P02.22** is set the maximum encoder rotating speed. Parameter **P02.22** is of access only when control signal **ON** is switched off;
- **Parameter P02.23** – second maximum spindle rotating speed at maximum motor rotating speed N_{MAX} . It is performed when input control signal N_{max1} is active. Parameter **P02.23** is of access only when control signal **ON** is switched off;
- **Parameter P02.24** – third maximum spindle rotating speed at maximum motor rotating speed N_{MAX} . It is performed when control signal N_{max2} is active. Parameter **P02.24** is of access only when control signal **ON** is switched off;
- **Parameter P02.25** – fourth maximum spindle rotating speed at maximum motor rotating speed N_{MAX} . It is performed when control signals N_{max1} and N_{max2} are active. Parameter **P02.25** is of access only when control signal **ON** is switched off;
- **Parameter P02.26** – work enabled with gearbox with shift paddles. This working mode is possible only in cases when the speed feedback is encoder at parameter **P02.16** = 1. Encoder is mounted on the machine spindle and between the motor and the spindle there is a reductor with shift paddles. Parameter **P02.26** is of access only when control signal **ON** is switched off. Parameter has two meanings:
 - **P02.26** = 0 – work with constant coefficient of transmission between the motor and the spindle. In this mode in parameter **P02.22** is set the encoder maximum rotating speed.
 - **P02.26** = 1 – work with shifting coefficient of transmission between the motor and the spindle. Encoder is mounted on the machine spindle. Working speed of the gearbox is chosen by control signals N_{max1} and N_{max2} .

Notes:

1. Maximum encoder pulses frequency at each phase is 220 kHz. When encoder is with 1024 puls/rev., maximum rotating speed is 12890 rev/min. When encoder is with 2500 puls/rev., maximum rotating speed is 5280 rev/min.;
 2. Motor rotating speed must not be more than maximum for each of chosen spindle rotating speeds.
- **Parameter P02.27** – defining the armature circuit resistance. Parameter has two meanings:
 - **P02.27** = 0 – armature circuit resistance is defined by motor nominal current and voltage;
 - **P02.27** = 1 – armature circuit resistance is defined dynamic when parameter **P02.26** = -1 as it is given in p.8.4 for converter primary starting work.

6.4.3 Group 03 – protection parameters

In the converter there are built-in hardware and software protections for the general controlling variables. All protections labeled with sign **S** are addressed to software and protection labeled with sign **H** to hardware.

Working threshold of software protections can be adjusted with parameters on dependent of the concrete use. Working threshold of the hardware protections are adjusted in the factory for converter protection and must not be changed.

If any protection activates the converter switches off the power rectifier and the corresponding LED indication lights.

The converter is ready for work after the reason of activating the protection is repaired and control signal **ON** is switched on again or electrical supply.

◆ **Software protection SPF - Soft Phase Fault**

- **Parameter P03.01** – admissible number of recorded breaks in synchronization before activating protection **SPF**. If recorded break number in synchronization is more than the value of parameter **P03.01**, protection **SPF** activates and the LED indication **PF** lights constantly;
- **Parameter P03.02 (P01.15)** – maximum number of the synchronization breaks recorded in sequence to its restore. Recording the breaks in synchronization starts at the moment of switching on the converter. By key **UP** or with switching off of the power supply indication is reset and it starts a new recording of the breaks. The meaning of parameter **P03.02** is not written in EEPROM. If recorded break number is more than the one written in **P03.01**, protection **SPF** activates. Parameter **P03.02** allows watching the quality of the power supply mains;
- **Parameter P03.03** – admissible time of synchronization deviation. Time of synchronization deviation defines the length of the time interval when the synchronization pulse is waited. Synchronization pulses out of this interval are recorded as an error (break in synchronization). The number of breaks is accumulated in the counter of protection **SPF**;
- **Parameter P03.04 (P01.14)** – maximum recorded time of deviation between waited and recorded synchronization pulse. By key **UP** or by switching off the power supply indication is reset and it starts a new recording of the deviation. The meaning of parameter **P03.04** is not written in EEPROM. Parameter **P03.04** allows monitoring the quality of power supply mains;

Note - software protections have priority. When there is not a phase of synchronization and a phase of power supply at the same time protection **SPF** activates and LED indication **PF** lights constantly.

◆ **Hardware protection HPF - Hard Phase Fault**

- **Parameter P03.05** – admissible number recorded breaks in sequence in power supply mains when protection **HPF** activates. Protection **HPF** records falling voltage in one or more phases of the power supply mains. Breaks in power supply mains are recorded by hardware and they enter into the counter of protection **HPF**. When the number of recorded breaks is more than the meaning of parameter **P03.05**, protection **HPF** activates and LED indication **PF** flicks with a period of time 1 s;
- **Parameter P03.06 (P01.16)** – maximum number of recorded breaks in sequence in power supply mains to its restore. Break recording starts at the moment of switching on the converter. By key **UP** or by switching off the power supply indication is reset and it starts a new break recording. The meaning of parameter **P03.06** is not written in EEPROM. If the number of break recording is more than the meaning written in **P03.05** protection **HPF** activates. Parameter **P03.06** allows monitoring the quality of the power supply mains;
- **Parameter P03.07** – working mode of hardware protection **HPF**. It has two meaning:
 - **P03.07 = 0** – in this mode protection **HPF** is switched off and appeared breaks in the power supply are not recorded in parameter **P03.06**. When there are any breaks in the power supply the converter is not switched off;
 - **P03.07 = 1** – in this mode protection **HPF** is switched on. When there are any breaks in the power supply they are recorded in parameter **P03.06**. When their number is more than the value of parameter **P03.05** the protection **HPF** activates. The converter is switched off and LED indication **PF** flicks with a period of time 1s;

◆ **Hardware protection FRF - FRequency Fault**

Hardware protection **FRF** activates at frequency of the power supply mains out of the limits 42 to 68Hz or there is not synchronization. When there is not any of operative voltage $\pm 12V$ the synchronization does not work, too. When protection **FRF** activates the LED indication **PF** flicks with a period of time 0.3s;

◆ **Software protection OLF – Over Load Fault**

- Parameter P3.08 – time when the protection **OLF** (I^2t) activates from lasting motor overloaded at meaning of the armature current more than nominal current $I_{a_{NOM}}$. When protection **OLF** (I^2t) activates LED indication **OL** lights constantly;
- Parameter P3.19 – enable the activating of protection **OLF** (I^2t) from lasting motor overloaded. It has two meaning:
 - **P3.19** = 0 – activating of protection **OLF** is switched off;
 - **P3.19** = 1 – activating of protection **OLF** is enable.

◆ **Hardware protection OHF – Over Heat Fault**

- Parameter P3.09 – enable activating the protection **OHF** from overheating of the converter power block. It has two meanings:
 - **P3.09** = 0 – activation of the protection **OHF** is switched off.
 - **P3.09** = 1 – activating the protection **OHF** is enable. When the temperature sensor of the power block switches on protection **OHF** activates and LED indication **OL** flicks with a period of time 1s;

◆ **Software protection SOS - Soft Over Speed**

- Parameter P3.10 – limited admissible rotating speed N_{LIM} . At rotating speed more than N_{LIM} the protection **SOS** activates and the LED indication **OS** lights constantly;

◆ **Hardware protection HOS - Hard Over Speed**

When the speed outline is correct adjusted for values of the velocity more than 104.8 % N_{MAX} the hardware protection **HOS** activates and the LED indication **OS** flicks with a period of time 1s.

◆ **Software protection RAF – RA Fault**

Protection of wrong defining of armature circuit resistance in automatic mode. When the protection **RAF** activates the LED indication **OS** flicks with a period of time 0.3 s;

◆ **Software protection SOC - Soft Over Current**

- Parameter P3.11 – limit moment current $I_{drv_{LIM}}$ in converter power rectifier. It is defined in percentage of the nominal motor current $I_{a_{NOM}}$. If power rectifier current is more than $I_{drv_{LIM}}$ the software protection of overcurrent **SOC** activates and LED indication **OC** lights constantly.

◆ **Hardware protection HOC - Hard Over Current**

Hardware protection **HOC** of overcurrent. It ensures converter protection when the current in power rectifier is more than the converter maximum admissible current $I_{drv_{MLIM}}$. The converter maximum admissible current $I_{drv_{MLIM}}$ is defined from the limited current of the converter power elements. Hardware protection **HOC** is adjusted in the factory. When the protection **HOC** is activated the LED indication **OC** flicks with a period of time 1s;

◆ **Software protection STG- Soft TachoGenerator fault**

- Parameter P3.12 – armature admissible voltage when the protection **STG** activates when there is any fault in the speed feedback. As a speed feedback sensor is used tachogenerator. The protection **STG** algorithm is realized as a comparison of the tachogenerator voltage to the

motor armature voltage. If the tachogenerator voltage is lower than 5% of the one at the maximum speed N_{MAX} , and the armature voltage is more than the meaning written in parameter **P03.12** for time more than 20 ms, the protection **STG** activates and the LED indication **TG** lights constantly. If values of parameter **P03.12** are low it is possible during the transition process the protection activates without real problem. And vice versa at high values of parameter **P03.12** it is possible at real problem in the speed feedback protection **STG** does not activate and the motor approaches high rotation speed.

◆ **Hardware protection ENF - ENcoder Fault**

Hardware protection **ENF** if there is any fault in the speed feedback when an encoder is used. If there is any fault in the speed feedback the protection **ENF** activates and the LED indication **TG** flicks with a period of time 1s;

◆ **Software protection PSB - Positive Speed Back**

Software protection **PSB** from positive speed feedback with tachogenerator or encoder. In case of wrong connection of the speed feedback sensor the protection **PSB** activates and the LED indication **TG** flicks with a period of time 0.3 s;

◆ **Software protection SOF – Soft Over Field**

- Parameter **P03.13** – maximum admissible field current I_{FLMAX} . It is recommended value of the parameter **P03.13** in range $115 \div 130$ % to the value of parameter **P04.02**. When field current is more than I_{FLMAX} protection **SOF** activates and LED indication **FL** lights constantly.

◆ **Software protection SFL - Soft Field Loss**

- Parameter **P03.14** – wound field maximum admissible current I_{FLMAX} . It is recommended the meaning of parameter **P03.14** is in range $50 \div 80$ % of the meaning of parameter **P04.04**. When wound field current is lower than I_{FLMAX} the protection **SFL** activates and the LED indication **FL** flicks with a period of time 0.3 s;

◆ **Hardware protection HFL - Hard Field Loss**

Hardware protection **HFL** activates in case of any loss in the motor wound field circuit. The threshold of the current when the hardware protection **HFL** activates is adjusted in the factory. When the hardware protection **HFL** activates the LED indication **FL** flicks with a period of time 1s;

◆ **Software protection OTE – Over Track Error**

Over the admissible tracking error. Protection **OTE** is used when the **orientation stopping** function is used.

- Parameter **P03.15** – admissible tracking error. When the current tracking error (current value of the difference between given and worked off pulses) become more than the value of parameter **P03.13** protection **OTE** activates and LED indication **TG** flicks with a period of time 0.3 s. in the converter adjusting mode protection **OTE** can be switched off by parameter **P03.15**;
- Parameter **P03.16** – extension of the protection **OTE** work from over tracking error. It has two meaning:
 - **P03.16** = 0 – protection **OTE** activating is switched off;
 - **P03.16** = 1 – protection **OTE** activating is switched on.

◆ **Software protection POE –POsition Error**

Error protection in position. If in time set in parameter **P08.10** the motor does not stop in position defined by the window set in parameter **P08.11**, the protection **POE** activates and the LED indication **TG** flicks with period of time 0.3 s.

◆ **Software protection OVM – Over Voltage Motor**

- **Parameter P03.17** – working threshold of the protection **OVM** of the motor armature overvoltage. The value of the parameter **P03.17** defines admissible overregulation of the armature voltage in percentages of the maximum voltage **U_{aMAX}** (parameter **P04.01**). If armature voltage overregulation is more than the value of the parameter **P03.17**, the protection **OVM** activates and the LED indication **OS** flicks with a period of time 0.3s. Protection **OVM** ensures safety work of the converter when there is any wrong adjustment of the parameters of the wound field current, protection **SFL** and of the EMF regulator;

◆ **Software protection FWF – Field Wait Fault**

- **Parameter P03.18** – time of field current stabilization. If after switching on the power supply or after activating control signal **ON**, field current is not stabilized at level more than 85% to the given current in time less than the value of parameter **P03.18**, protection **FWF** activates and LED indication **FL** flicks with a period of time 0.3 s;

◆ **Hardware protection ADC - Analog Digital Converter Fault**

Hardware protection **ADC** if there is something wrong in the analog-digital converter work and the processor. When the protection **ADC** activates the LED indications **FL**, **TG**, **OC**, **OS**, **OL** and **PF** light constantly.

◆ **Hardware protection EEF - EEprom Fault**

Hardware protection **EEF** if there is something wrong in the EEPROM work. Hardware protection **EEF** activates at primary converter starting with a new software, too. To get away the problem in this case it is necessary the default parameters to be set. When the protection **EEF** activates the LED indications **FL**, **TG**, **OC**, **OS**, **OL** and **PF** flicks with a period of time 1s.

6.4.4 Group 04 – motor parameters

- **Parameter P04.01** – maximum armature voltage **U_{aMAX}** in volts;
- **Parameter P04.02** – wound field nominal current **I_{FNOM}** [A], it depends on the current range chosen by parameter **P02.10**;
- **Parameter P04.03** – minimum wound field working current **I_{FMIN2}**, in the second zone in amperes. The device works in the second zone with motor constant power;
- **Parameter P04.04** – minimum wound field working current **I_{FMIN3}**, in the third zone in amperes. The device works in third zone with decreased motor power;
- **Parameter P04.05** – wound field current **I_{FON}**, when the control signal **ON** is switched off, in amperes. The wound field current **I_{FON}** is stable 10 s after switching off the control signal **ON**. When the wound field current is **I_{FON}** the heating of non-working motor is reduced;
- **Parameter P04.06** – nominal motor speed in its table. Motor speed when it comes in the second zone in work with weaken field mode;
- **Parameter P04.07** – maximum motor speed in its table. Maximum motor working speed in weaken field mode;
- **Parameter P04.08** – actual maximum motor speed. Maximum working motor speed in work with weaken field mode, as it is lower than the value of parameter **P04.07**;
- **Parameter P04.09** – limit armature current at nominal field in the first zone (**P04.02**). It is defined in percentage of the armature nominal current **I_{aNOM}**. The curve of dynamic current limitation according to the speed is given in **figure 15**. In the first zone value of current limitation is constant and in this zone the motor torque is constant, too;
- **Parameters P04.10** – limit of armature current at minimum field in the second zone (**P04.03**). it is defined in percentage to the nominal armature current **I_{aNOM}**. In the second zone value of the dynamic current limitation is changed at law **1/n** according to the speed, as at this the

motor power in this zone is constant. The curve of dynamic current limitation in the second zone is given in **figure 15**;

- **Parameter P04.11** – limit of armature current at minimum field in the third zone (**P04.04**). it is defined in percentage of the armature nominal current $I_{a\text{NOM}}$. In the third zone value of the dynamic current limitation is change at law $1/n$, but the motor power in this zone decreases with increasing the speed. When the motor does not work in the third zone at **P02.07** = 1 it is recommended to set values in parameters **P04.03** = **P04.04** and **P04.10** = **P04.11**.

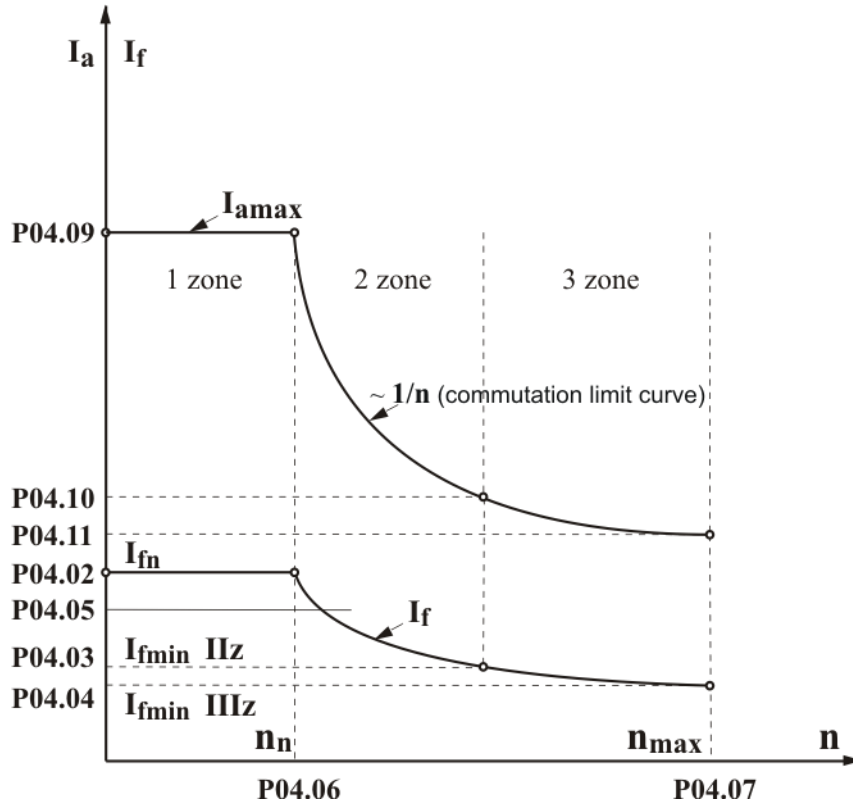


Figure 15 Graphic of dynamic current limit characteristic

6.4.5 Group 05 – speed regulator parameters

- **Parameter P05.01** – time of the rampgenerator. The value of the parameter **P05.01** defines the time in which the maximum speed is approached and the time of stopping;
- **Parameter P05.02** – offset of the speed reference;
- **Parameter P05.03** – coefficient of amplification of the speed regulator **Kp1**. Range of acting of the coefficient of amplification **Kp1** is defined of the threshold given of the meaning of parameter **P05.05**. When the adaptation variable is changed from the value of parameter **P05.05** to the value of parameter **P05.06**, the coefficient of amplification of the speed regulator is changed in linear law to meaning **Kp2**. In case of adaptation on actual speed, the coefficient of amplification **Kp1** must be equal or more than the coefficient of amplification **Kp2**;
- **Parameter P05.04** – coefficient of amplification of the speed regulator **Kp2**. The range of acting of the coefficient of amplification **Kp2** is defined by the threshold given with the value of parameter **P05.06**;
- **Parameter P05.05** – threshold of variable for work of the coefficient of amplification **Kp1**. To the value of the chosen adaptation variable defined by parameter **P05.05**, the speed regulator works with coefficient of amplification **Kp1**. For values more than the value of parameter **P05.05** and less than the value of parameter **P05.06**, the coefficient of amplification of the regulator is changed on linear law from **Kp1** to **Kp2**;

- **Parameter P05.06** – threshold of variable for work of the coefficient of amplification **Kp2**. For values of the chosen adaptation variable more than the one defined by parameter **P05.06**, the speed regulator works with coefficient of amplification **Kp2**;
- **Parameter P05.07** – time constant of the speed regulator **Tn1**. The acting range of the time constant **Tn1** is defined by the threshold given by the meaning of parameter **P05.09**. When the adaptation variable is changed from the value of parameter **P05.09** to the value of parameter **P05.10**, the speed regulator time constant is changed in linear law to meaning **Tn2**. In case of adaptation on actual speed the time constant **Tn1** must be equal or less than the time constant **Tn2**;
- **Parameter P05.08** – time constant of the speed regulator **Tn2**. The acting range of the time constant **Tn2** is defined by the threshold given by the value of parameter **P05.10**;
- **Parameter P05.09** – threshold of the variable of time constant **Tn1** work. To the value of the chosen adaptation variable defined by parameter **P05.09**, the speed regulator works with time constant **Tn1**. For values more than the value of parameter **P05.09** and less than the value of parameter **P05.10** the regulator time constant is changed in linear law from **Tn1** to **Tn2**;
- **Parameter P05.10** – threshold of variable of time constant **Tn2** work. Over the value of chosen adaptation variable defined by parameter **P05.10**, the speed regulator works with time constant **Tn2**;
- **Parameter P05.11** – differential time constant of the speed regulator **Dt1**. The activating range of the differential time constant **Dt1** is defined by the threshold, given as value in parameter **P05.13**. When the adaptation variable is being change from the value of parameter **P05.13** to the value of parameter **P05.14**, the differential time constant of the speed regulator is changed at the linear law from **Dt1** to **Dt2**;
- **Parameter P05.12** – differential time constant of the speed regulator **Dt2**. Activating range of the differential time constant **Dt2** is defined by the threshold, given as value of parameter **P05.14**;
- **Parameter P05.13** – variable threshold for work with differential time constant **Dt1**. To the value chosen by the adaptation variable, defined by parameter **P05.13**, speed regulator works with time constant **Dt1**. For values more than the value of parameter **P05.13** and less than the value of parameter **P05.14**, the differential time constant of the regulator is changed at linear law from **Dt1** to **Dt2**;
- **Parameter P05.14** – variable threshold for work of the differential time constant **Dt2**. For meaning of chosen adaptation variable more than the meaning of parameter **P05.14**, the speed regulator works with time constant **Dt2**;

6.4.6 Group 06 – armature current parameters

- **Parameter P06.01** – coefficient of amplification of the armature current regulator;
- **Parameter P06.02** – time constant of the armature current regulator;
- **Parameter P06.03** – adjustment of the phase **L1** current amplitude;
- **Parameter P06.04** – adjustment of the phase **L2** current amplitude;
- **Parameter P06.05** – adjustment of the phase **L3** current amplitude;
- **Parameter P06.06** – offset of the armature current. It is used at uncompensated static load of the vertical axes in repose mode (axis stays in position);
- **Parameter P06.07** – time of the armature current rampgenerator. It is used for softing the strikes of the gears during the transients when it is used the ones, or the tachogenerator has fluctuations higher than 2% calculated by **P01.12** in stable working mode.

6.4.7 Group 07 – EMF regulators and wound field current parameters

- **Parameter P07.01** – coefficient of amplification of the wound field current regulator;
- **Parameter P07.02** – integral time constant of the wound field current regulator;

- **Parameter P07.03** – coefficient of amplification of the EMF regulator. When the EMF regulator is optimum adjusting the overregulation of the armature voltage is limited at transients including at reversing the motor;
- **Parameter P07.04** – time constant of the EMF regulator;
- **Parameter P07.05** – differential time constant of the EMF regulator.

6.4.8 Group 08 – orientation stopping parameters

- **Parameter P08.01** – acceleration at getting rotating 1. It is inserted the motor acceleration at start positioning;
- **Parameter P08.02** – deceleration at stopping 1. It is inserted the motor deceleration at stopping in the search speed;
- **Parameter P08.03** – acceleration at getting rotating 2. It is inserted the motor acceleration at start searching the zero point;
- **Parameter P08.04** – deceleration at stopping 2. It is inserted the motor deceleration at stopping in zero point;
- **Parameter P08.05** – coefficient of amplification of the position regulator Kp. For coefficients more than 1 it is possible position overregulation (the shaft goes on and return in position). For coefficients less than 1 the current position is in arrear of the given by profilegenerator position and at position it will stop with an error;
- **Parameter P08.06** – enable searching given position mode;
- **Parameters P08.07** – current tracking error. It points the error between current value of given position by profilegenerator and the its current value;
- **Parameter P08.08** – maximum recorded tracking error. It points the maximum recorded error between the moment values of given by profilegenerator position and its current value in pulses. By the key **UP** of the terminal or by switching off the converter from mains the pointing is reset and it starts a new deviation recording.
- **Parameter P08.09** – adjusting the tracking error. It influences on the current tracking error directly, as at low values it is registered a delay of the current error (the sign of the error is the same as the rotating direction), and at high values it is registered outrunning of the current position (the sign of the error is opposite to the rotating direction). At very high values it is observed overregulation and vibration. Optimal adjusting is observed at a little being in arrear;
- **Parameter P08.10** – position window. Window in pulses around the position target, as when the current position comes into the window the end of the position is registered;
- **Parameter P08.11** – time for position is being fixed. Maximum admissible time from approaching the given by profilegenerator position to coming the current position into the position window **P08.10**;
- **Parameter P08.12** – current position error. It points the deviation of the current position from the position target;
- **Parameter P08.13** – zero position. It is set the value of the position after ending the position process;
- **Parameter P08.14** – position speed. It is set the maximum speed of moving at position approaching;
- **Parameter P08.15** – speed direction at searching the zero pulse.
 - **P08.15 = 0** – positive direction;
 - **P08.15 = 1** – negative direction;
 - **P08.15 = 2** – the same direction.
- **Parameter P08.16** – source of the position speed:
 - **P08.16 = 0** – from parameter **P08.14**;
 - **P08.16 = 1** – by series interface.
- **Parameter P08.17** – speed of zero pulse searching. It is set the maximum speed of moving at searching the zero pulse.

6.4.9 Group 09 – input parameters

- **Parameter P09.01** – type of digital input **IN1**. The digital input can be programmed to perform each function given in **table 3**, as in parameter **P09.01** is set the number of the function. By default the digital input **IN1** is programmed to perform function **bit0** with number 27. Function **bit0** in this case is the junior bit of the parallel code of the digital speed reference. Digital input function are described in detail in **p.5.1.1**;
- **Parameter P09.02** – inverting the logical level of the digital input **IN1**. Parameter **P09.02** has two meaning:
 - **P09.02 = 0** - the active logical level of the digital input **IN1** is the same. The digital input activates when a signal with high level $\pm 24\text{ V}$ ($\pm 13\div 30\text{ V}$) is given;
 - **P09.02 = 1** - the active logical level of the digital input **IN1** is inverted. The digital input activates when a signal with low level 0 V ($\pm 0\div 7\text{ V}$) is given;
- **Parameters P09.03 ... P09.36** – programming the type and active logical level of the digital inputs from **IN2** to **IN18**.

6.4.10 Group 10 – output parameters

- **Parameter P10.01** – speed threshold **N_{ZS}**, under which relay output **ZS** activates. Meaning of the parameter **P10.01** is defined in percentage of the maximum speed **N_{MAX}**. Changing of the parameter **P10.01** is in the limits $0.01 \div 15.0\% \text{ N}_{\text{MAX}}$;
- **Parameter P10.02** – time for confirming the change of the signal **ZS**. Time during which the output does not change its status;
- **Parameter P10.03** – threshold **N_{SA}** of speed window when the function **achieved speed SA** is performed. The speed window is defined in the range $(\text{N}_{\text{REF}} - \text{N}_{\text{SA}}) \div (\text{N}_{\text{REF}} + \text{N}_{\text{SA}})$. When at increasing or decreasing the current speed it comes into the window the digital output **SA** activates. Meaning of the parameter **P10.03** is defined in percentage to the speed reference **N_{REF}**. Changing of the parameter **P10.03** is in the limits $0.00 \div 30.00\% \text{ N}_{\text{REF}}$;
- **Parameter P10.04** – time for confirming the change of the signal **SA**. Time during which the output does not change its status;
- **Parameter P10.05** – speed from which the work of digital output **SA** is enable. Parameter **P10.05** defines speed under which activating of the function **achieved speed** is not enable. Parameter **P10.05** has meaning from 0.00 to 15% of the maximum speed **N_{MAX}**;
- **Parameter P10.06** – time for confirming the change of the signal **INPOS**. Time during which the output does not change its status;
- **Parameter P10.07** – current **I_{aTLH}**, to which motor current at control signal **TLH** is limited. It is defined in percentage to the nominal motor current **I_{aNOM}**. Parameter **P10.07** has meaning from 10.0 to 100.0 % **I_{aNOM}**;
- **Parameter P10.08** – current **I_{aTLL}**, to which motor current at control signal **TLL** is limited. It is defined in percentage to the nominal motor current **I_{aNOM}**. Parameter **P10.08** has meaning from 1.0 to 100.0 % **I_{aNOM}**;
- **Parameter P10.09** – type of digital output **OUT1**. The digital output can be programmed to perform each function given in **table 4**, as in parameter **P10.09** is set the number of the function. By default the digital output **OUT1** is programmed to perform function **achieved torque limitation TLL** with number 1. The functions of the digital outputs are described in detail in **p.5.1.2**;
- **Parameter P10.10** – inverting the logical level of the digital output **OUT1**. Parameter **P10.10** has two meaning:
 - **P10.10 = 0** – the active logical level of the digital output **OUT1** is the same. In this mode the active status of the digital output **OUT1** is a closed relay contact;
 - **P10.10 = 1** – the active logical level of the digital output **OUT1** is inverted. In this mode the active status of the digital output **OUT1** is a open relay contact.

- Parameters **P10.11 ... P10.18** – programming the type and active logical level of the digital outputs from **OUT2** to **OUT5**;
- Parameter **P10.19** – choice of the variable for analog output **AOUT1** (see **table 13**);
- Parameter **P10.20** – choice of the variable for analog output **AOUT2** (see **table 13**);
- Parameter **P10.21** – choice of the range of analog output **AOUT1** – 2.0 to 10.0V;
- Parameter **P10.22** – choice of the range of analog output **AOUT2** – 2.0 to 10.0V;

Parameters P10.19 and P10.20	Active variable of the analog outputs
1	Absolute actual meaning of the armature current from 0 to I_{aMAX} .
2	Absolute actual meaning of the motor rotating speed from 0 to I_{aMAX} .
3	Actual meaning of the motor rotating speed.
4	Absolute meaning of the speed reference from 0 to +100%.
5	Actual meaning of the speed reference from –100% to +100%.
6	Absolute meaning of the armature current reference from 0 to I_{aMAX} .
7	Absolute meaning of the actual armature current from 0 to I_{aMAX} .
8	Actual meaning of the field current from 0 to I_{FNOR} .
9	Actual absolute meaning of the armature voltage. Range of the analog output from 0 to +10V, corresponding to the changing of the armature voltage from –600 to +600 V.
10	Actual meaning of the armature voltage, corresponding to the changing of the voltage from –600 to +600 V.
11	Actual meaning of the EMF, corresponding to the changing of the voltage from –600 to +600 V.
12	Absolute meaning of the actual EMF, corresponding to the changing of the voltage from 0 to +600 V.

Table 13 Choice of the analog output variables **AOUT1** and **AOUT2**

6.4.11 Group 11 – terminal parameters

- Parameter **P11.01** – choice of the terminal language. At adjusting it is chosen a menu language. It is not restore in default of. It has three meaning:
 - **P11.01** = 0 – English language;
 - **P11.01** = 1 – Bulgarian language;
 - **P11.01** = 2 – Russian language.
- Parameter **P11.02** – time of refreshing of the terminal indication.

6.4.12 Group 12 – error history

- Parameters from **P12.01 to P12.16** – parameters in which it is stored messages of errors in order of their appearance. If in a certain parameter there is not any message of error in it is written **EMPTY**. The messages of errors are written by text corresponding to the **table 14**. Last written message of error is stored in the parameter with the largest number. After fulling all parameters the oldest messages are reset automatically;
- Parameter **P12.17** – reset all of the error messages.

6.5 Errors in emergency mode

Appearing of the message **Error N XX** on the terminal display means an error, whose number is given in the last two orders. The message of an error is appeared at its registration independent of that in which mode is the converter. Recording error messages are stored in parameters in group **P12** in the sequence of their appearing. After pressing the button **ESC**, the terminal status before error appearing, is restored. The list of error messages is given in **table 14** and in **table 15** is given the LED indication status when the emergency mode appears.

Error №	Text	Error description
Error N01	Soft Phase Fault	Disconnecting or out of phase power and synchronization voltages. Wrong ground connection of the converter.
Error N02	Hard Phase Fault	Disconnection of the power supply voltage or the voltage of any of the phases.
Error N03	FR equency Fault	Power supply mains frequency is out of the admissible range or there is not synchronization.
Error N04	OverLoad Fault	The motor is overloaded.
Error N05	OverHeat Fault	Power block is over heated when P03.09=1
Error N07	Soft OverCurrent	Limited current Idrv_{LIM} of the converter power block is more than given by parameter P03.11 .
Error N08	Hard OverCurrent	Maximum admissible current Idrv_{MLIM} of the converter power block is over current.
Error N10	Soft TG fault	Wrong connection, short circuit or disconnection in the tachogenerator circuit. Wrong choice of the parameter P02.16
Error N11	EN coder Fault	Wrong connection, short circuit or disconnection in the encoder circuit.
Error N12	Pos SpeedBack	Positive speed feedback.
Error N13	Soft Over Field	Wound field current is more than the maximum admissible meaning.
Error N14	Hard Field Loss	There is not wound field current.
Error N15	Soft Field Loss	Field current is less than the minimum admissible meaning.
Error N16	Soft OverSpeed	Overspeed according to the one given by parameter P03.10 limited speed N_{LIM}
Error N17	Hard OverSpeed	Overspeed the maximum limited speed N_{MLIM} .
Error N18	OverVoltage Mot	Over voltage the maximum admissible armature voltage.
Error N19	ADC fault	There is something wrong in analog-digital converter.
Error N20	EE prom Fault	Error at work with EEPROM.
Error N31	PO sition Error	Error at position.
Error N 32	OverTrack Error	Error at tracking
Error N35	Field Wait Fault	Error at stabilization of the field current
Error N38	RA Fault	Error at defining of the armature circuit resistance Ra automatically.

Table 14 List of the errors

Note: Letters in bold respond to the protection meaning given in **p.6.4.3**.

Indication	Protection	Emergency mode description
LEDs lighting constantly		
PF	SPF	Disconnection or out of phase power and synchronization voptages. Wrong ground connection of the converter.
OL	OLF	The motor is overloaded.
OS	SOS	Overspeed according to the one given by parameter P03.14 limited speed N_{LIM} .
OC	SOC	Overcurrent according to given by parameter P03.11 limited current Idrv_{LIM} of the converter power block.
TG	STG	Wrong connection, short circuit or disconnection in the tachogenerator circuit. Wrong choice of parameter P02.16 .
FL	SOF	Wound field current is more than the maximum admissible meaning.
FL,TG,OC, OS,OL,PF	ADC	Fault in the analog-digital converter.
LEDs flicking with a period of time 1s		
PF	HPF	Disconnection of the power supply voltage or the voltage of any phase.
OL	OHF	Overheating of the power block when P03.09=1

OS	HOS	Overspeeded of the maximum limited speed N_{MLIM} .
OC	HOC	Overcurrent of the maximum admissible current $I_{drv_{MLIM}}$ of the converter power block.
TG	ENF	Wrong connection, short circuit or disconnection in the encoder circuits.
FL	HFL	Absence of the wound field current.
FL,TG,OC, OS,OL,PF	EEF	Error at work with EEPROM.
LEDs flicking with a period of time 0.3 s		
PF	FRF	The power supply mains frequency is out of the admissible range or absence of the synchronization.
TG	PSB	Positive speed feedback.
TG	OTE	Tracking error.
FL	SFL	Field current is less than the minimum admissible meaning.
FL	FWF	Error at field current stabilization.
OS	OVM	Overvoltage of the maximum admissible armature voltage
OS	RAF	Error at defining of the armature circuit resistance R_a automatically.

Table 15 Converter LEDs indication status when there is any emergency mode.

7. Assembling and connecting of the converter

7.1 General technical requirements to the assembling

The converters and belonging to them commutative and protection equipment are mouted in a cabinet. When they are mounted it is necessary to observe the following rules:

- The converter is mounted in the vertical position. Its fixing must be made by opening for this purpose holes placed at the down and upper parts of the frame;
- Over and under the converter it is necessary to leave free space, no less than 100 mm, which ensure a vertical air circulation through the radiator of the power block;
- Use possible the shortest cables;
- Signals' conductors must not be mounted next to the power cables;
- Connecting of the analog signals must be made by screen cable and the screen is connected to the ground only at the one end. The screen must be connected to X2.9, X2.10, and X2.11. The screen must not be used as a current-carrying conductor;
- Keep the value and the types of the protection elements, given in **table 16** and the minimum sections of the connecting conductors in correspondence to the circuits in **figure 16**, **figure 17** and **figure 18**;
- Electrical connections must be performed in correspondence to the circuits in **figure 16**, **figure 17** and **figure 18**;

	4025	4030	4040	4050	4060
TC1	50 mm ²	50 mm ²	70 mm ²	90 mm ²	100 mm ²
TC2	35/50 mm ²	50 mm ²	50 mm ²	70 mm ²	90 mm ²
TC3	16 mm ²	25 mm ²	35 mm ²	50 mm ²	50 mm ²
TC4	16 mm ²	25 mm ²	25 mm ²	35 mm ²	50 mm ²
TC5	2.5 mm ²				
TC6	3x1.00 mm ²				
TC7	screen + 3x3 + 2x0.35 mm ²				
TC8	screen + 2x0.35 mm ²				
TC9	1.0 mm ²				
QF1 (auto off) Shneider Electric, Kat №	Compact NB250N 31559-250A	Compact NB400N 32678-300A	Compact NB400N 32676-400A	Compact NB600N 32877-500A	Compact NB600N 32876-630A
Choke	PK022550	PK023060	PK024080	PK0250100	PK0260120
Fuses FUS и FUT	10 / 16 / 25 A				
Fuses FU, FV и FW	0.315A				

Table 16 Minimum section of the connecting conductors, types and value of the protecting elements.

Notes:

1. It is allowed to use devices of other manufacturers with the same characteristics;
2. It is admissible using other chokes with inductivity no less than 0.2 mH and if they ensure normal work at nominal and maximum motor current.

7.2 Connecting of the converter

Connecting of the converter depends on its type, on the type of the circuit of the motor wound field supply, on the type for speed feedback sensor, on the type of CNC and on functions, which the converter performs.

In **figure 16** is given connecting the converter of which:

- Supply of the wound field power part is with a transformer **TF1** and it is recommended for motors with field 110 – 220 V. Secondary voltage must be with 25 – 50 % more than the motor field voltage;
- It is used a tachogenerator for a sensor of speed feedback;
- It is used an analog speed reference;
- It is used a limitation of the motor torque **TLL**;
- It is used outer reset of the protections **RESET**.

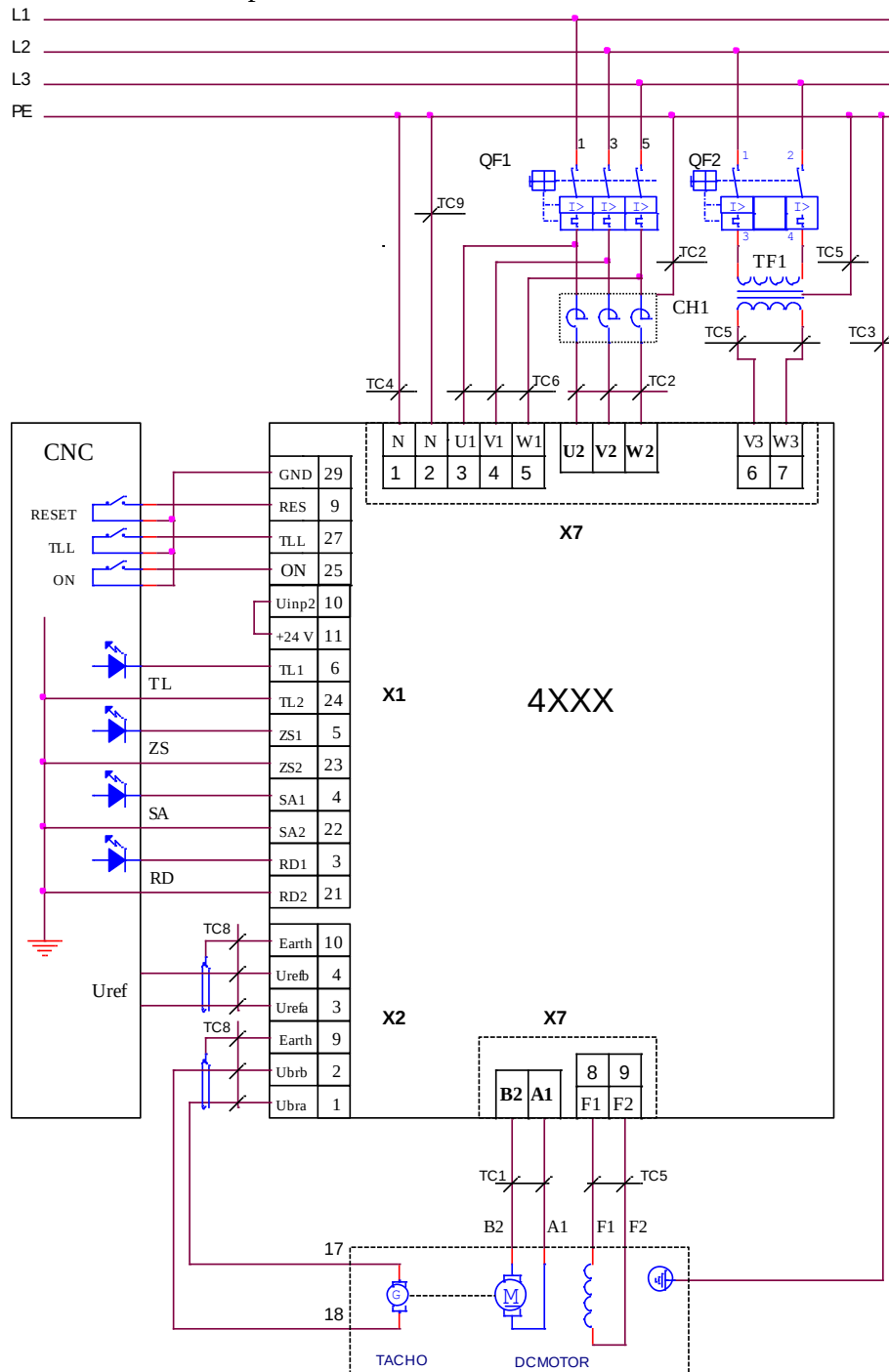
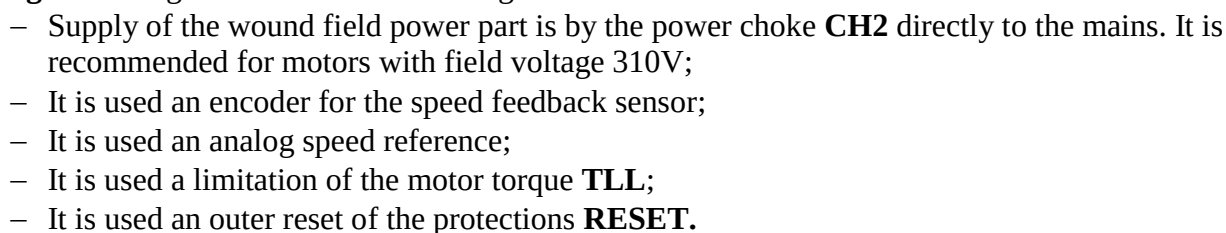


Figure 16 Circuit of the converters connecting

In **figure 17** is given converter connecting of which:



The diagram illustrates the electrical connections for a CNC machine, showing the interface between the CNC control unit, the motor unit (4XXX), and the motor assembly (X3).

CNC Control Unit:

- RESET, TLL, ON: Connected to the top power rail (L1).
- TL, ZS, SA, RD: Connected to the middle power rail (L2).
- Uref: Connected to the bottom power rail (PE).
- Ground: Connected to the bottom power rail (PE).

Motor Unit (4XXX):

- Inputs:** N, U1, V1, W1, U2, V2, W2, V3, W3.
- Outputs:** RES, TLL, ON, Uinp2, +24 V, TL1, TL2, ZS1, ZS2, SA1, SA2, RD1, RD2, Earth, Urefb, Urefa.

Motor Assembly (X3):

- Inputs:** 12, 9, 6, 5, 4, 3, 2, 1.
- Outputs:** GND, +5V, /C, C, /B, B, /A, A.

Motor and Encoder:

- DC MOTOR:** Connected to the motor unit outputs (F1, F2, A1, B2).
- ENCODER:** Connected to the motor unit outputs (A1, B2).

Thermal Cut-off (TC) Switches:

- TC1, TC2, TC3, TC4, TC5, TC6, TC7, TC8, TC9: Protect various power lines and motor connections.

In **figure 18** is given connecting of the converter, at which:

- Supply of the armature is by reducing transformer or autotransformer and it is recommended for motors with armature voltage 110 – 220 V. Primary and secondary coils must have the same circuits of switching on;
- It is used digital speed reference. For reference with 12 bits code it must be set meaning of parameters **P09.21** = 37 and **P09.23** = 38.

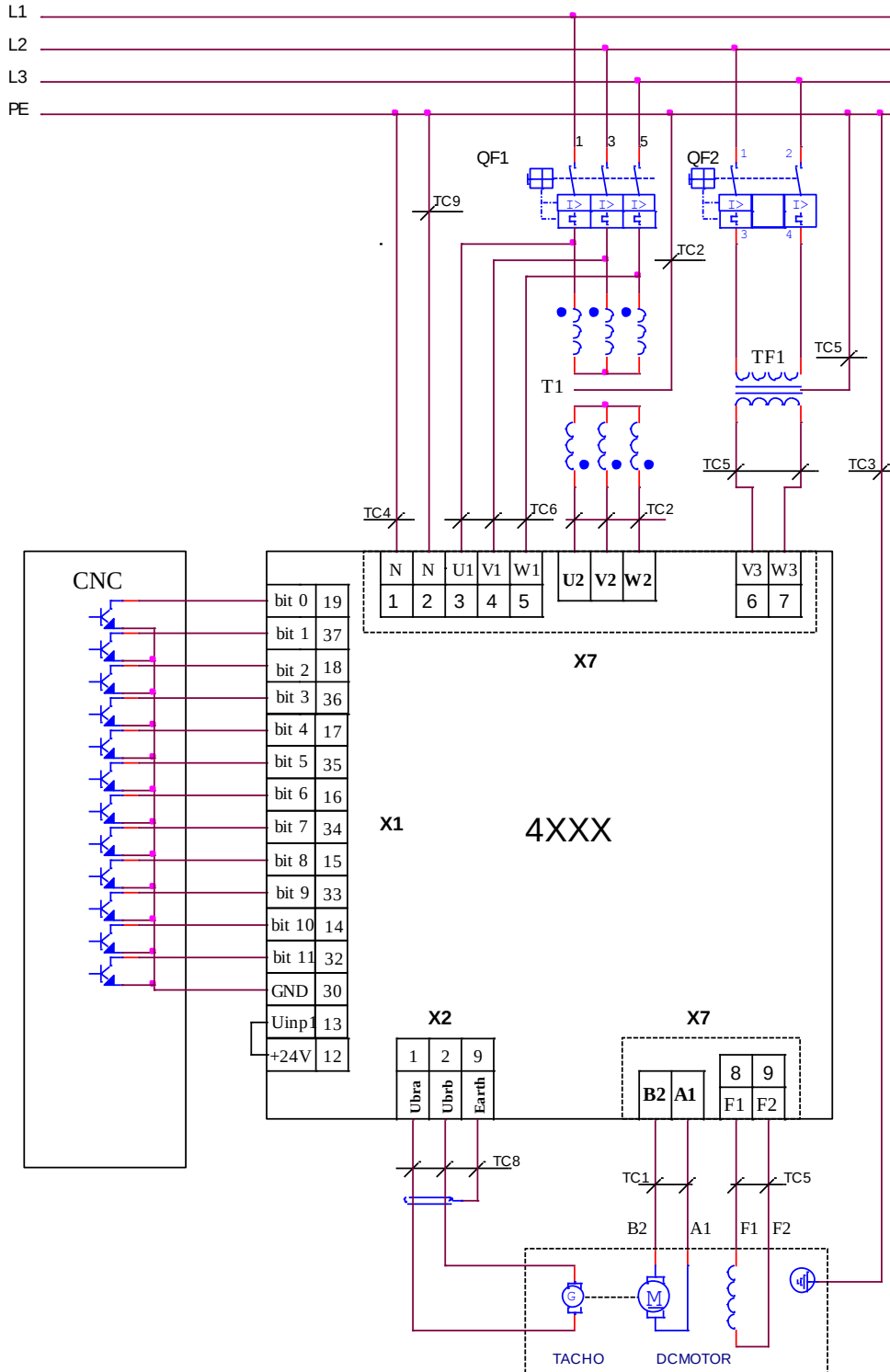


Figure 18 Circuit of the converters connecting

8. Connecting and adjusting of the converter

For starting the converter are necessary the next equipments:

- Voltmeter with range to 500 V_{AC/DC}, class 1.5;
- Digital revolution-meter;
- Amperemeter with range to +/-10A_{DC}, class 1.5;
- Oscilloscope;
- Switcher for controlling signal **ON**;
- Switcher for switching the rotation direction **SF** / **SR**;
- Switcher for switching of **RUN** / **STOP**;
- Variable resistor 10 K;
- Terminal for adjusting the parameters.

8.1 Checking the supply voltages

To the converter are connected operative voltage **U1**(X7.3), **V1**(X7.4) and **W1**(X7.5) and power supply voltage **U2**, **V2** and **W2**, according to the circuit given in **figure 19**. During this checking the motor is not switched on to the converter.

To the series interface **X6** of the converter is switched on special terminal for adjusting the parameters.

Switch on the power supply voltage to the converter and LED **RD** activates.

Measure the voltage between terminals **U1**(X7.2) and **U2**(X7.5). If the connection is right the voltage between them is equal to 0V. If case the voltage between them is 380V, it means that there is an error in connection. Switch off the voltage and repair the error. The same action is repeated for **V1**(X7.3) and **V2**(X7.6) and for **W1**(X7.4) and **W2**(X7.7). The order of the phases is no matter and it is defined automatically by the coverter.

Transformer **TF1** isolates galvanic the motor wound field coil from supply mains. It carries the voltage between wound field coil and the compensation coil of the motor, and it is decreased the possibility of electrical break between them. Using of a transformer is recommended at motors which are worked more part of their resources. At choice of a tranformer **TF1** it is necessary to ensure the nominal voltage and current of the motor wound field.

ATTENTION!

Primary coil of the transformer TF1 must be connected to phases L2 and L3, and the secondary coil is connected to terminals with lables V3(X7.6) and W3(X7.7) as it is given in figure 16 and figure 19.

After finishing this checking, supply of the converter is switched off.

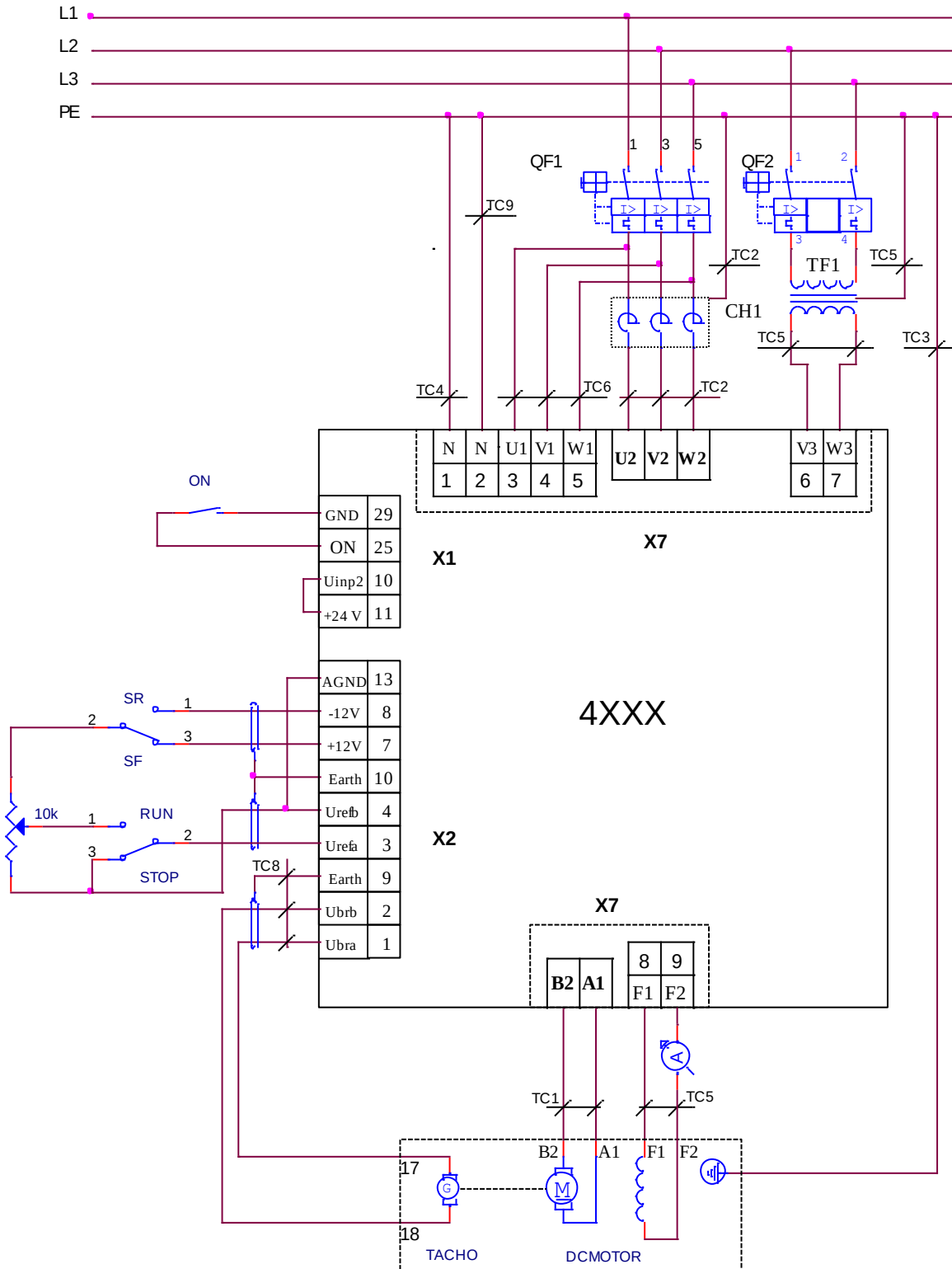


Figure19 Connection circuit of the converter at adjusting.

8.2 Primary converter adjusting

8.2.1 Primary adjusting of the speed feedback

- **speed feedback with tachogenerator**

The converter is adjusted to work with tachogenerator by default of and parameter

P02.16 = 0.

The tachogenerator voltage U_{br_MAX} at the motor maximum rotating speed is defined by the expression:

$$U_{br\_MAX} = (N_{MAX} / 1000) * U_{br1000}$$

where:

N_{MAX} – the motor maximum rotating speed;

U_{br1000} – tachogenerator voltage at 1000 min⁻¹.

By so calculated maximum tachogenerator voltage U_{br_MAX} it is chosen the voltage range in **table 6**. The converter face panel is opened and the protection cover of the processor plate is moved down. Bridges **A1, A2, A3, J5** and **J6** are placed in positions corresponding to the given combination for the chosen range from **table 6**.

- **Speed feedback by encoder with constant coefficient of transmission**

Switch on the converter supply and insert the password **P02.02 = 11**. According to the type of the encoder insert the meaning of the following parameters:

- Parameter **P02.16 = 1** – it chooses an encoder as a speed feedback sensor;
- Parameter **P02.21** – insert the number of the pulses per a revolution of the encoder;
- Parameter **P02.22** – insert the rotating speed of the encoder at maximum motor speed;
- Parameter **P02.26 = 0** – It forbids the speed shift. By default **P02.26 = 0**.

- **Speed feedback with encoder with changeable coefficient of transmission**

Switch on the converter supply and insert the password **P02.02 = 11**. According to the type of the encoder insert the meaning of the next parameters:

- Parameter **P02.16 = 1** – it chooses an encoder as a speed feedback;
- Parameter **P02.21** – insert the number of the pulses per a revolution of the encoder;
- Parameter **P02.26 = 1** - permission of the work with gearbox with speed shift. By default **P02.26 = 0**;
- Parameter **P02.22** – insert the maximum speed of the encoder for the **first** maximum speed. It is performed when control signals **Nmax1** and **Nmax2** are not active;
- Parameter **P02.23** – insert the maximum speed of the encoder for the **second** maximum speed. It is performed when the control signal **Nmax1** activates;
- Parameter **P02.24** – insert the maximum speed of the encoder for the **third** maximum speed. It is performed when the control signal **Nmax2** activates;
- Parameter **P02.25** – insert the maximum speed of the encoder for the **fourth** maximum speed. It is performed when the control signals **Nmax1** and **Nmax2** are active at the same time.

- **Speed feedback with motor EMF**

Switch on the converter supply and insert the password **P02.02 = 11**. Insert the meaning of the following parameters:

- Parameter **P02.16 = 2** – choose the motor EMF as a speed feedback sensor;
- Parameter **P02.07 = 0** – choose the work without weakened motor field.

Note – in this case the maximum motor speed responds to the nominal motor speed and it is achieved at voltage U_{a_MAX} , which meaning is written in parameter **P04.01**. If it is necessary a lower maximum speed in parameter **P04.01** must be written corresponding to lower voltage.

8.2.2 Adjusting the parameters connected to the motor

Insert the meaning of the parameters which define working and limiting characteristics of the motor:

- Parameter **P04.01** – maximum motor armature voltage **U_{aMAX}** in volts;
- Parameter **P04.02** – nominal wound field current **I_{FNOM}**. Insert the meaning of the wound field nominal current from the motor table in amperes;
- Parameter **P02.07** – working mode of the converter with weakened motor field. From the motor table it is defined in how many zones the motor will work and insert the corresponding meaning in parameter **P02.07**;
- Parameter **P04.03** – minimum working wound field current **I_{FMIN}** in amperes, corresponding to the motor maximum speed in the second zone. The meaning of the parameter **P04.03** is set when **P02.07** = [1, 2];
- Parameter **P04.04** – minimum working wound field current **I_{FMIN}** in amperes, corresponding to the motor maximum speed in the third zone, if the motor can work in it. The meaning of the parameter **P04.04** is set when **P02.07** = 2;
- Parameter **P04.05** – motor wound field current **I_{FON}** in amperes when the control signal **ON** switched off. At primary starting of the converter the meaning of the parameter **P04.05** is chosen to be equal to the meaning of the parameter **P04.02**. Precise calculated the meaning of the parameter **P04.05** is given in **p. 8.3**;
- Parameter **P03.17** – threshold of activating of the protection **OVM** from overvoltage of the armature;
- Parameter **P03.13** – maximum admissible wound field current **I_{FLMAX}** in amperes over which the protection **SOF** activates. At primary converter starting the meaning of the parameter **P03.13** is the same as in default of. Pricise defining of the meaning of the parameter **P03.12** is given in **p. 8.3**;
- Parameter **P03.14** – minimum admissible wound field current **I_{FLMIN}** in amperes, under which the protection **SFL** activates. At the primary converter starting the meaning of the parameter **P03.14** is the same in default of. Pricise defining of the meaning of the parameter **P03.14** is given in **point 8.3**;

As a model of adjusting the parameters using the data from motor table is given in the following examples:

Example 1 – a motor with two zones

Motor table:

Motor power	kW	3.17	156	156
Speed	min-1	30	1260	2360
Armature voltage	V	10	420	420
Armature current	A	404	406	408
Field voltage	V	310	310	54
Field current	A	9.35	9.35	3.85

For this motor insert the following meaning of the parameters:

P02.07 = 1; **P02.08** = 408; **P04.01** = 420; **P04.02** = 9.35; **P04.03** = 3.85;

P04.04 = 3.85; **P04.05** = 6.00; **P04.06** = 2360; **P04.07** = 2360

If the actual maximum motor speed is less than the maximum speed, set in parameter **P04.07**, its meaning is set in parameter **P04.08**.

Equivalent resistance of the resistors **R65**, **R66**, **R67** must correspond to the meaning of parameter **P02.08**.

Example 2 – a motor with three zones

Motor table:

Motor power	kW	4.4	130	130	80
Speed	min-1	50	1090	2400	3000

Armature voltage	V	48	400	400	400
Armature current	A	390	392	395	220
Field voltage	V	310	310	77	51
Field current	A	14.25	14.25	4.55	3.65

For this motor insert the following meaning of the parameters:

P02.07 = 2 **P02.08** = 395 **P04.01** = 400
P04.02 = 14.25 **P04.03** = 4.55 **P04.04** = 3.65 **P04.05** = 8.00
P04.06 = 1090 **P04.07** = 3000 **P04.11** = 56

The actual maximum motor speed is inserted in parameter **P04.08**.

Equivalent resistance of the resistors **R65**, **R66**, **R67** must correspond to the meaning of parameter **P02.08**.

8.3 Adjusting the wound field current

The supply is switched off and the motor is connected to the converter as in series in the wound field coil circuit is connected amperemeter with range 12 A_{DC}.

Check if the range of the wound field current sensor corresponds to the rated wound field current. Also check whether the meaning of parameters **P02.10** and **P02.11** correspond to this motor.

By standard in the converter is mounted a current sensor with range 25A – **P02.11** = 25A.

The conductor with label **F1** is placed in the terminals of the power plate as followed:

- **SW5** for range 6.5 A;
- **SW4** for range 10 A;
- **SW5** for range 20 A;

Places of the terminals **SW3**, **SW4** and **SW5** on the power plate is given in **figure 13**.

8.3.1 Adjusting the motor with known field data

Switch on the converter supply again. Control signal **ON** is switched off and the amperemeter measures the wound field current **I_{FON}**.

When the measured by the amperemeter data do not correspond to the current reference check the corresponding parameters **P02.10** and **P02.11** with the mounted sensor and the chosen range.

By parameter **P04.02** is regulated the motor wound field current to approaching its passport nominal meaning **I_{FNOM}**. At each changing the meaning of the parameter **P04.02**, automatically in time about 8 – 10 s the motor wound field current is defined by parameter **P04.02** and it is registered by the amperemeter. After finishing the time the wound field current **I_{FON}** is equal to the current defined by parameter **P04.04**. The meaning of the parameter **P04.02** must be more or equal to the meaning of the parameter **P04.05**.

After adjusting the wound field nominal current **I_{FNOM}**, by parameter **P04.05** is defined the wound field current **I_{FON}** when the control signal **ON** is switched off. It is recommended meanings in range of 50–100% of the meaning of parameter **P04.02**.

Insert in parameter **P04.03** the meaning of the minimum wound field working current **I_{FMIN2}** in the second zone from the motor table. If on the table of the motor this current is not given, the meaning of the parameter **P04.03** is chosen about 20 % or more of the meaning of the parameter **P04.02**.

During the adjusting, so as not to activate the protections **SFL** and **SOF**, it is necessary to keep the following:

- Minimum wound field current **I_{FLMIN}** of protection **SFL**, defined by parameter **P03.14**, must have meaning about 50 ÷ 80% of the minimum wound field working current **I_{FMIN2}**, defined by parameter **P04.03** for motors working in the two zones;
- Maximum admissible wound field current **I_{FLMAX}** of the protection **SFL**, defined by parameter **P03.13**, must have meanings between 115% and 130% of the nominal wound field current **I_{FNOM}**, defined by parameter **P04.02**.

8.3.2 Adjusting the motor with unknown field data

If the nominal wound field current I_{FNOM} is unknown, and only the wound field voltage U_{FNOM} is known, the wound field current is defined on the following manner:

- Measure the active resistance of the field wound at room temperature;
- Measured resistance is multiplied by the coefficient **1.2** and the result is the resistance R_F of the field coil when the motor is heated;
- Calculate the field current I_{FNOM} by expression:

$$I_{FNOM} = U_{FNOM} / R_F$$

The converter power supply is switched on, and the calculated value of the nominal field current I_{FNOM} is set in parameters **P04.02** and **P04.05**. Measure the field voltage at the terminals **F1** and **F2**, which must be about 80% to the nominal voltage of the cool motor.

Adjusting the minimum field current in the second zone is defined as a percentage to the nominal current, defined from the range of regulation in the second zone (the correlation of the nominal to the maximum speeds). For compensation of the nonlinearity of changing the field current in the second zone, set in parameter **P04.03** a meaning less than the calculated.

Others parameters are defined as in **p.8.3.1**.

It is recommended after starting the device in integral mode to do one more checking for correct adjustment of the field current. The motor rotating speed is increasing lightly and at the moment, when the armature voltage increasing stops the motor speed is measured.

If the meaning of the field current is set correctly, the speed at which the device enters the second zone correspond to the nominal speed, given in the motor table plus 10% at motor idling work.

If the field current is less than the needed meaning, the device enters the second zone at speeds higher than the nominal. In this case the meaning of the current must be increased.

For field current more than the needed one, the device enters the second zone at speeds lower than the nominal and therefore it must be decreased.

Speed decreasing, when the field current is increased, is possible not to be more because of the saturated the steel, expressing in weak increasing of the magnetic flux in comparison with the field current.

Attention: High field current leads to the overheating of the field coil.

Notes:

1. If the adjusting nominal field current is higher than the nominal motor current from the table during the transient (sharp speed changing) it is possible the protection **OVM** activates by the overvoltage of the armature at speeds, near to the nominal one, because of the saturating of the field current regulator;
2. If the adjusting nominal field current is lower than the nominal motor current, it is observed increasing the armature current because of the decreasing the torque and overloading (overheating) the motor;
3. At high minimum field current it is possible the protection **OVM** activates from overvoltage the armature voltage at speeds near to the maximum one;
4. At very low minimum field current it is possible practical the motor stays without excitation at high speeds and a cycle fire can appear or the motor can be damage mechanically;
5. At motors with high class isolation, the field coil resistance in hot status may become 130% or more than the resistance in cool status.

8.4 Starting of the converter in proportional mode

Primary converter starting with a motor is made in proportional mode. In this mode the speed regulator and the current regulator work only with proportional component and with a EMF speed

feedback. The motor can work at low speed when the tachogenerator/encoder is switched off or it is not in-phase. The protection of the speed feedback fault is also switched off. In proportional mode of converter work is made checking of the tachogenerator, adjusting of the circuit of the speed feedback and checking if all of the thyristor work.

Starting of the converter in proportional mode is made by inserting the meaning of the parameter **P02.06** = 1. Changing of the parameter **P02.06** is not written in the EEPROM and at each converter switching on the meaning of the parameter **P02.06** = 0, i. e. the converter works in integral mode.

The control signal **ON** is switched on and the motor rotates.

By parameter **P01.12** the fluctuations of the tachogenerator voltage are monitored. When the tachogenerator is in good working order, in stable mode, the value of parameter **P01.12** must not be more than 2%. At value of parameter **P01.12**, more than 2%, it is necessary to check or repair the tachogenerator.

To check if the tachogenerator connecting is correct compare the values of parameters **P01.02** and **P01.05**. If the tachogenerator connecting is correct the two parameters must be with equal signs. When the values of the parameters **P01.02** and **P01.05** have different signs, it is possible following two cases:

- The motor rotating direction responds to the given reference. Change the tachogenerator connecting or the meaning of parameter **P02.19**;
- The motor rotating direction is opposite to the given reference. Change the motor armature connecting.

When it is used an encoder as a speed feedback sensor, checking the correctitude of its connecting is made as it is compared the meanings of parameters **P01.02** and **P01.05**. When the connecting of the encoder is correct the two parameters must be with equal signs. When the values of the two parameters are with different signs it is possible two cases:

- The motor rotating direction responds to the given reference. Change the encoder connecting (for example two phases – **A** and **/A**) or the meaning of parameter **P02.20**;
- The motor rotating direction is opposite to the given reference. Change the motor armature connecting.

In proportional mode is made adjusting the channel of the speed feedback. By changing the thyristor firing angle is given a defined rotating speed, for example 10% of the maximum speed **N_{MAX}**, measured by digital revolution-meter. By the variable resistor **RP5**, given in **figure 20** the meaning of parameter **P01.02** (reduced from % to speed) and the indication of the revolution-meter are made equal.

To check the work of the power rectifier thyristors choose the parameter **P01.17**. The control signal **ON** is switched on and it is given a low rotating speed - for example 5 % from **N_{MAX}**. When the thyristors work normally on the terminal indication are appeared two groups of six zeros 000000 000000, first of them for the one rotating direction, and the second for the other direction. Appearing of the **1** in a certain order means that the corresponding thyristor does not work. The number of the order with **1** corresponds to the number of the thyristor in the electrical circuit from **T12** to **T1** from left to right.

Dynamic defining of the armature circuit resistance is recommended when the information of the motor is incompleted.

The procedure is performed when parameters **P02.06** = -1 and **P02.27** = 1.

When the control signal **ON** is switched on, and the field current is switched off for time of 10s, 5 short pulses are given automatically to the armature circuit, after that the armature circuit resistance is calculated and written.

If there is a large difference between the calculated and the defined by the set nominal data meanings, the protection **RAF** activates. In this case it must check if the set motor data are correct or its good working order – for example if there is any shunt in the armature circuit.

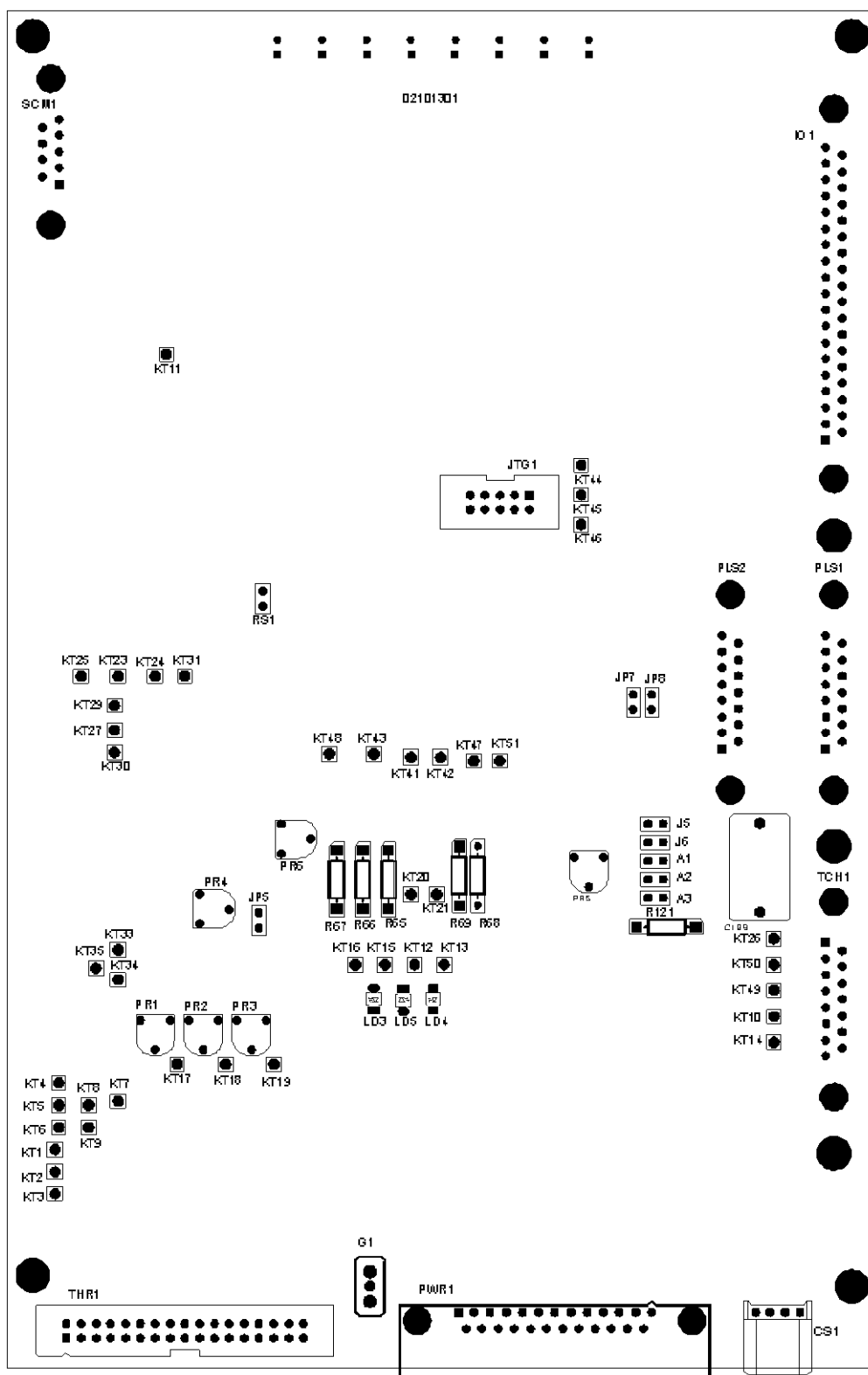


Figure 20: Places of the adjusting elements on the processor PCB

8.5 Checking the converter work in integral mode

After finishing the adjustment in proportional mode the control signal **ON** is switched off. Insert value of parameter **P02.06** = 0 for moving in integral work mode. Choose value of parameter **P05.01** (time of the ramp generator) according to requiring device dynamics and inert mass of the load. At high value of parameter **P05.01** the motor works with low accelerations.

Switch on the control signal **ON** and increase the rotating speed slowly and watch the armature voltage by parameter **P01.05**, and wound field current by parameter **P01.06**. Register the voltage when the wound field current starts decreasing and the device enters the second zone. If the device does not enter the second zone, check if the field coil is connected correct, according to the circuits in **figure 16**, **figure 17** and **figure 18** (do not use phase **L1**).

For precise calibrating of the speed feedback give the speed reference 50% of the maximum speed N_{MAX} . Measure the motor rotating speed by a revolution-meter and calculate the ratio of actual speed to maximum motor speed N_{MAX} , in percentage. Compare the calculated ratio to the value of parameter **P01.02**. If it is necessary fix the precise value of parameter **P01.02**, by the variable resistor **RP5**.

After finishing the adjustments and if there is a controlling device higher level (CNC), to the converter is connected controlling interface. After that the converter is checked in all requiring machine working modes. When all of the requirements are done the machine is ready for work. Switch off the supply voltage and the converter is closed.

8.6. Adjusting the device with unusual (unknown) motor

When the factory converter adjusting does not satisfy the requirements for quality of regulation, it is recommended after inserting the motor parameters and checking in proportional mode, adjust the armature current, speed, and EMF regulators. For the quality of the adjusting it is judged by the transitions of the curves of armature current and motor speed.

Switch off the power supply. Ensure the motor idling, including the dismantling the machine.

• Adjusting the wound field current regulator

Watch the form of the wound field current curve at the controlling point **KT51** by the oscilloscope. Give the zero rotating speed, switch on the control signal **ON** and watch the increasing of the wound field current. After switching off the control signal **ON** and time about 10s, the wound field current decreases to I_{FON} , defined by parameter **P04.04**. The optimal form of the wound field current characteristic during the transient is given in **figure 21**.

For adjusting the field current regulator it is used parameters **P07.01** and **P07.02**. Parameters **P07.01** and **P07.02** have the following influence on the current regulator work:

- parameter **P07.01** – coefficient of amplification of the field current regulator. Typical values of the parameter **P07.01** are from 0.40 to 2.00. At high values of the parameter **P07.01** the tendency to selfexcitation is increased. At low values of the parameter **P07.01** time for approaching the given field current is increasing;
- parameter **P07.02** – time constant of the field current regulator. Typical values of the parameter **P07.02** are from 80 to 200 ms. At low values of the parameter **P07.02** the reaction of the field current is increased, but at the same time the tendency to fluctuation is increased. At high values of the parameter **P07.02** the time of approaching the field current reference is increased.

At high values of the parameter **P07.01** and low values of the parameter **P07.02**, it is observed overregulation and tendency to field current fluctuation, during the transition. The form of the field current curve is given in **figure 22**.

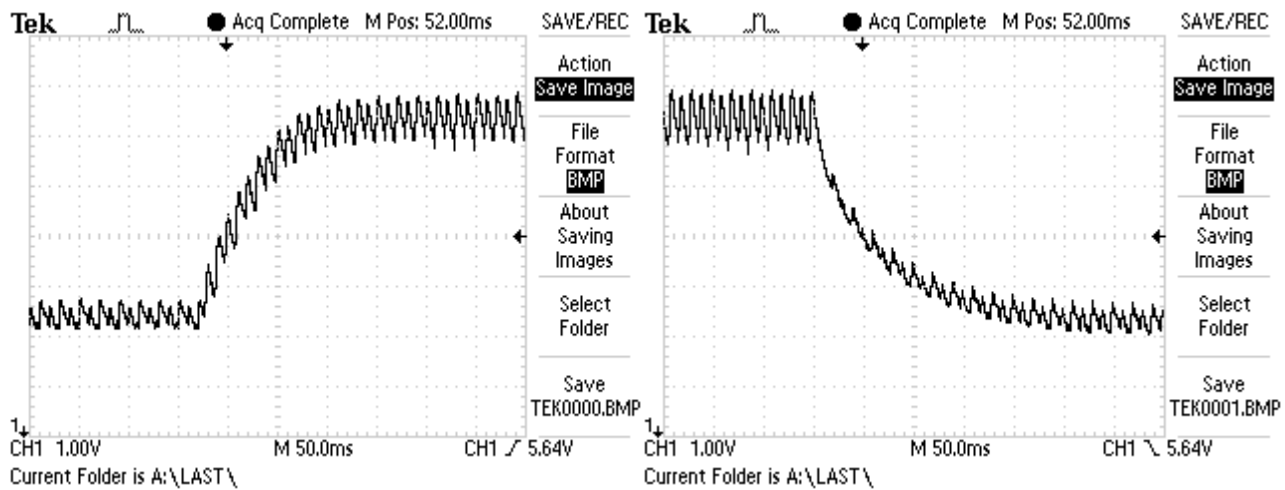


Figure 21 Form of the current characteristic at optimal adjustment of the wound field current regulator

At low value of parameter **P07.01** and high value of parameter **P07.02**, it is observed a lasting transient at approaching to given wound field current. The form of the wound field current characteristic is given in **figure 23**.

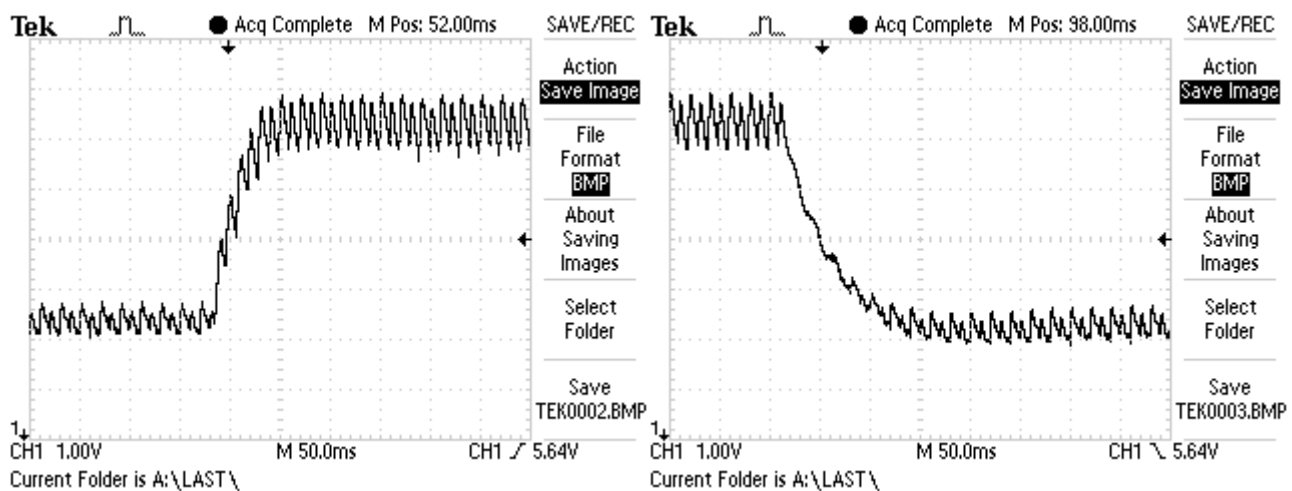


Figure 22 Form of the wound field current characteristic at high value of parameter **P07.01** and low value of parameter **P07.02** with overregulation and tendency to fluctuation

- **Adjusting the armature current regulator**

Switch on the converter power supply. Insert the password with parameter **P02.02** = 11. For switching off the ramp generator insert value of the parameter **P05.01** = 0. Switch on the control signal **ON**.

Give speed reference at a leap from zero to 80% of the nominal speed. Watch the form of the armature current form at the controlling point **KT20** by the oscilloscope. The armature current must approach its maximum value to the fourth pulse without any visible overregulation, as the amplitude of the fourth and fifth pulses must not be over the stable maximum value. After that give zero speed at a leap and watch the armature current form again.

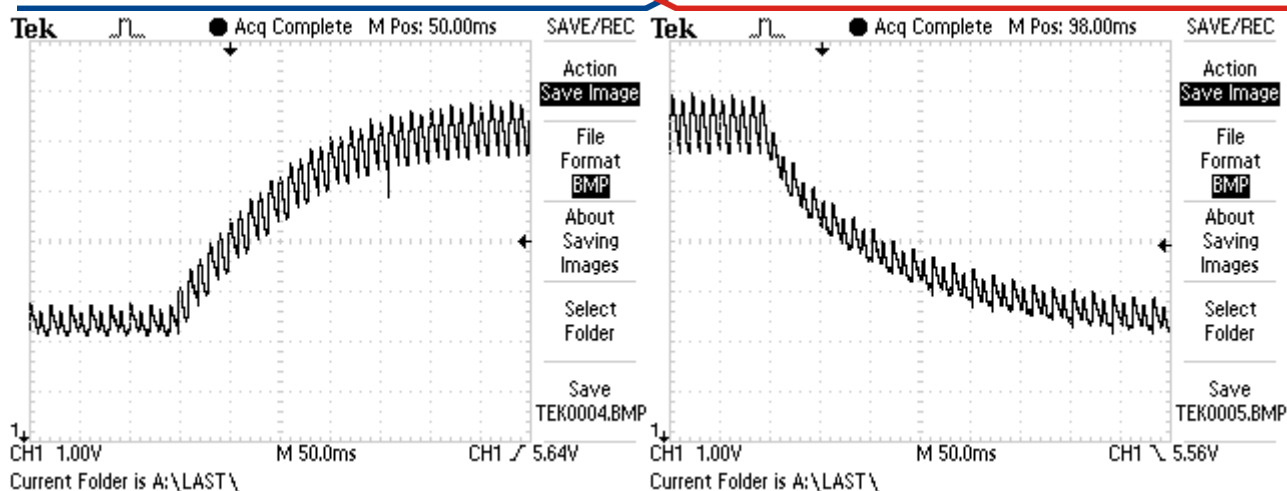


Figure 23 Form of the wound field current characteristic with lasting transient at low value of parameter **P07.01** and high value of parameter **P07.02**

Optimal form of the armature current characteristic, at running and stopping the motor is given in the **figure 24**. Armature current is in absolute measurement without a sign.

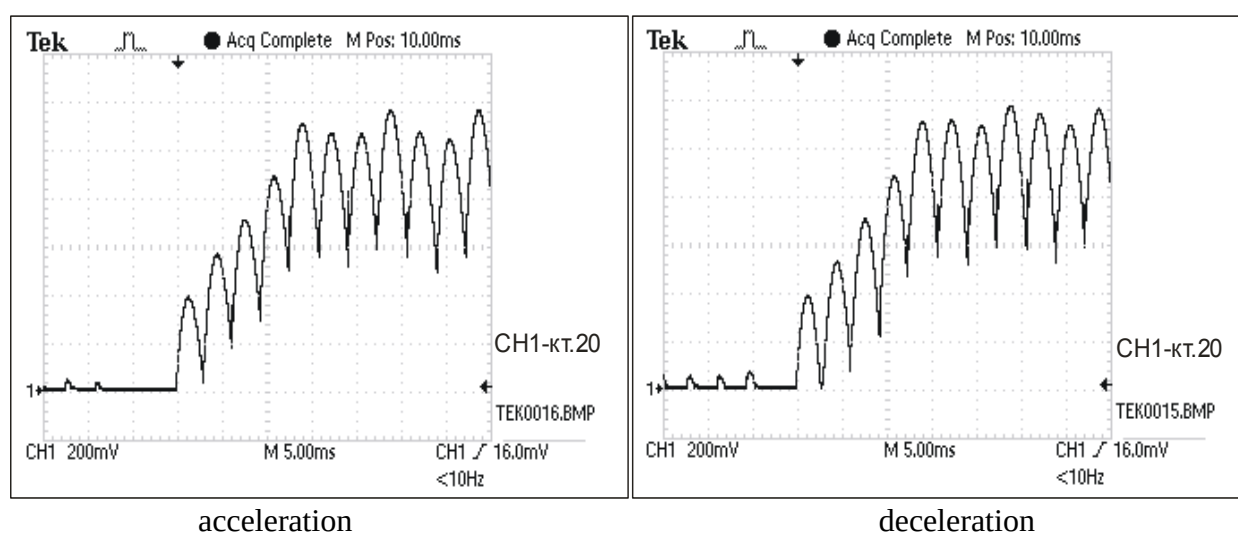


Figure 24 Form of the armature current characteristic at running and stopping when the adjusting of the armature current regulator is optimal

For adjusting the current regulator use parameters **P06.01** and **P06.02**. The parameters **P06.01** and **P06.02** influence on the work of the current regulator as following:

- Parameter **P06.01** – coefficient of amplification of the current regulator. Typical values of parameter **P06.01** are from 0.10 to 0.50. At high values of the parameter **P06.01** the “hard” of the device increases and its tendency to its selfexcitation, too. At low value of the parameter **P06.01** the time for approaching the stable current is increased;
- Parameter **P06.02** – time constant of the current regulator. Typical values of parameter **P06.02** are from 12.0 to 40.0 ms. At low values of parameter **P06.02** the speed of the current regulator reaction increases and its tendency to selfexcitation increases, too. At high values of parameter **P06.02** the time of approaching to the stable current increases.

At high value of parameter **P06.01** and low value of parameter **P06.02** it is watched high current overregulation during the transients. The armature current characteristic with overregulation at running and stopping are given in **figure 25**. In this case it is possible the protection **SOC** activates.

At low value of parameter **P06.01** and high value of parameter **P06.02** it is watched a lasting transient to approaching the stable current. The armature current characteristic at running and stopping with lasting transient are given in **figure 26**.

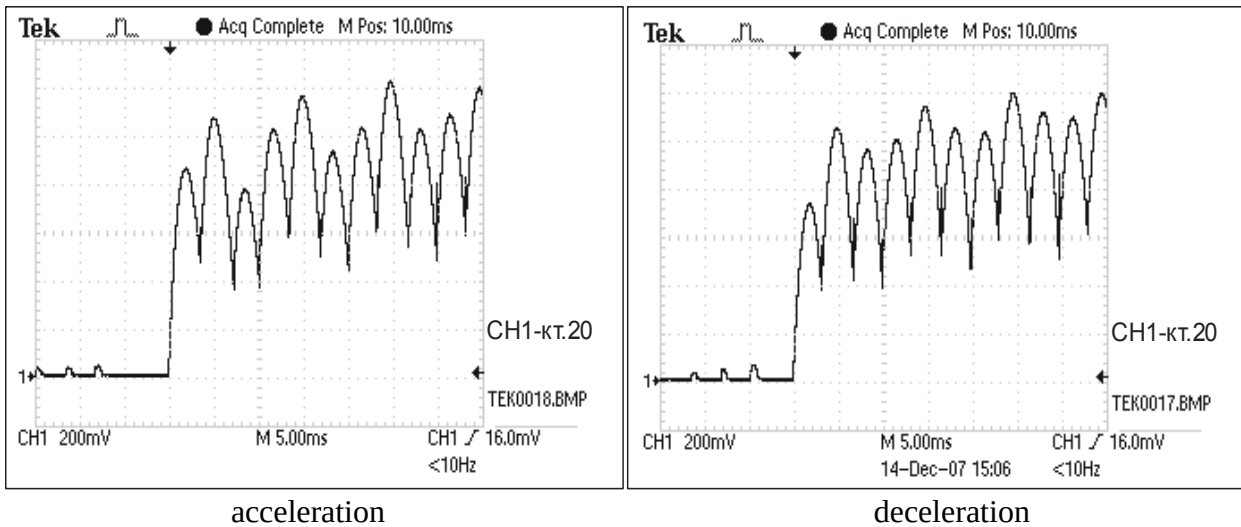


Figure 25 Armature current characteristics with overregulation at high meaning of parameter **P06.01** and low meaning of parameter **P06.02**

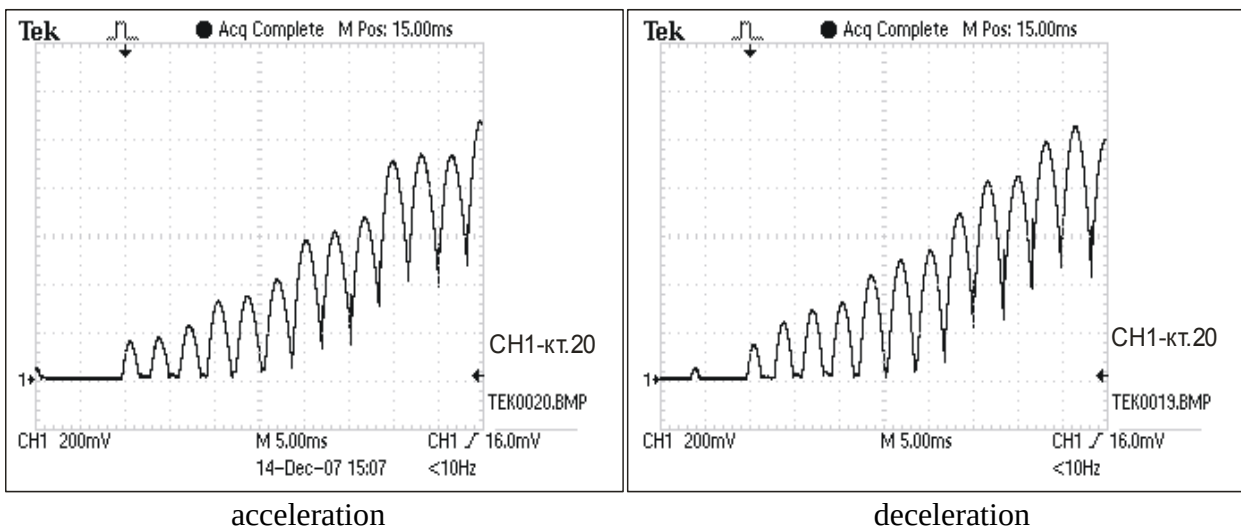


Figure 26 Armature current characteristics with lasting transient at low value of parameter **P06.01** and high value of parameter **P06.02**

- **Adjusting the speed regulator**

After adjusting the current regulator check the speed regulator.

The speed regulator is with adaptive adjustment of its parameters in function of actual speed when **P05.11** = 0 or in function of the speed error when **P05.11** = 1. In default of the adaptive adjustment of the speed regulator is in function of actual speed.

Adaptive speed regulator permits the range of regulation to be expanded no less than 1:10000, which permits better work in position work.

Adjusting the speed regulator is made at two levels – at low rotating speeds in the first zone and at high rotating speed in the second zone.

Give a speed reference at a leap from zero value to 90 % of the nominal speed. Watch the form of the speed characteristic in control point **KT26** by oscilloscope. It is admissible one leap of

the speed that is not more than 5% of the stable value. When there are fluctuations in the speed and high overregulations, by parameters **P05.03** to **P05.10** it is adjusted the speed regulator.

By default the speed regulator is adjusted with high dynamics at low speeds, that is needed at position mode (for example at the oriented stopping) and it is defined by the following parameters:

- Parameters **P05.03** – coefficient of amplification of the speed regulator. The typical values of the parameter **P05.03** are from 5.0 to 30.0. At high values of the parameter **P05.03** the “hard” of the device increases and its tendency to selfexcitation (fluctuation) at the stopping point, too. At low values of parameter **P05.03** the error of the position reference increases;
- Parameters **P05.07** – time constants of the speed regulator. Typical values of the parameter **P05.07** are from 100 to 600 ms. At low values of the parameter **P05.07** the reaction speed of the speed regulator increases and its tendency to selfexcitation increases, too. At high values of the parameter **P05.07** the time for approaching the given position increases.

In the range of the high speed the speed regulator is adjusted by parameters **P05.04** and **P05.08**.

At high values of the parameter **P05.04** and low values of the parameter **P05.08** is observed high overregulation of the speed during the transient. At low values of the parameter **P05.04** and high values of the parameter **P05.08** is watched a lasting transient to achieving to the given speed.

After that give zero speed at a leap and watch the form of the speed transient.

Transients at speed 90% of the nominal speed (work only in the first zone) for optimal adjusted regulator at acceleration, deceleration and reverse of the motor are given in **figure 27**.

Check the transients at a leap maximum speed reference, for checking the device work in working zones with weakened field.

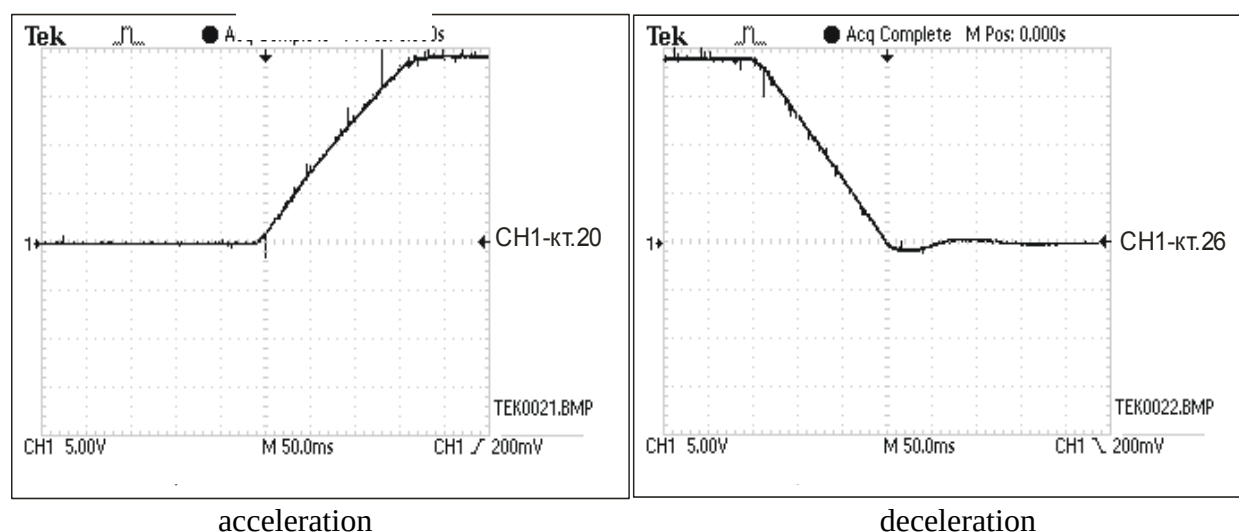
Transients at maximum speed for optimal adjusting speed regulator at acceleration, deceleration and reverse are given in **figure 28**.

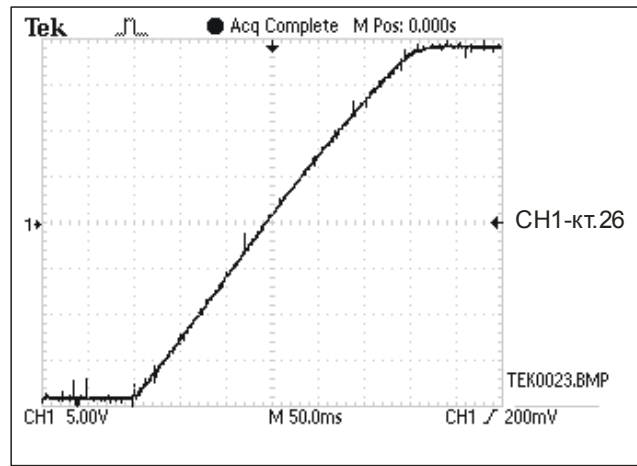
The oscillation at reverse has S-shaped form because of the dynamic current limitation of the motor armature current, which leads to decreasing of the acceleration when the speed is increases.

After finishing adjusting the current and speed regulators set the meaning of the parameter **P05.01** (time of the rampgenerator), according to the desired dynamic of the device and inert load.

• Adjusting of the EMF regulator

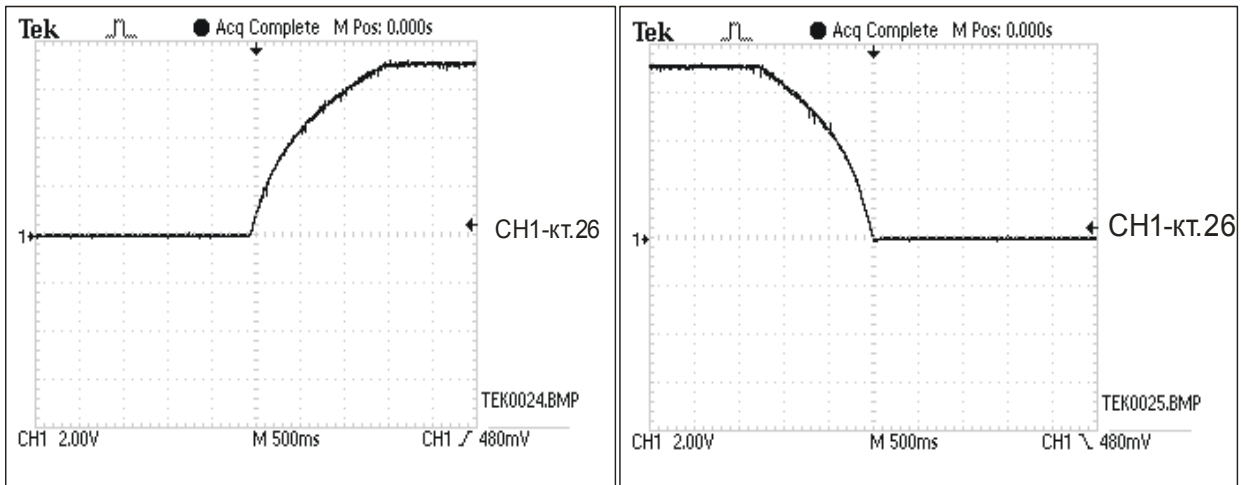
For adjusting the **EMF** regulator give the rotating speed 90 % of the maximum speed of the motor and do the reverse of the spindle. Watch the field current at controlling point **KT51** and the armature voltage at controlling point **KT48** by oscilloscope. Optimal diagrams of the armature voltage characteristic and ftded current characteristic are given in **figure 29**.





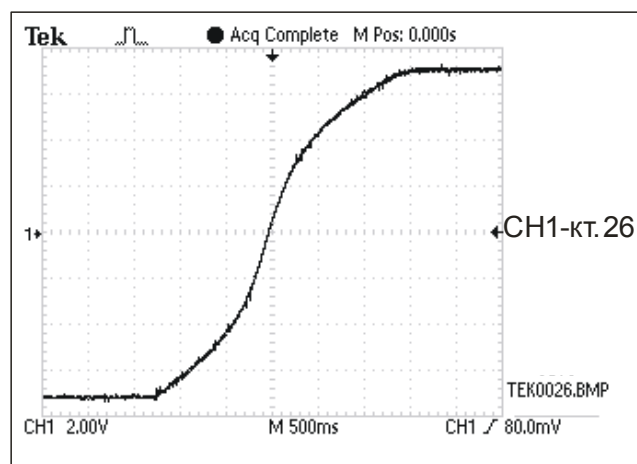
Reverse

Figure 27 Characteristics of the speed during the acceleration, deceleration, and reverse at optimal adjusting of the speed regulator in the first working zone



acceleration

deceleration



Reverse

Figure 28 Speed characteristics at acceleration, deceleration, and reverse at optimal adjustment of the speed regulator at maximum speed

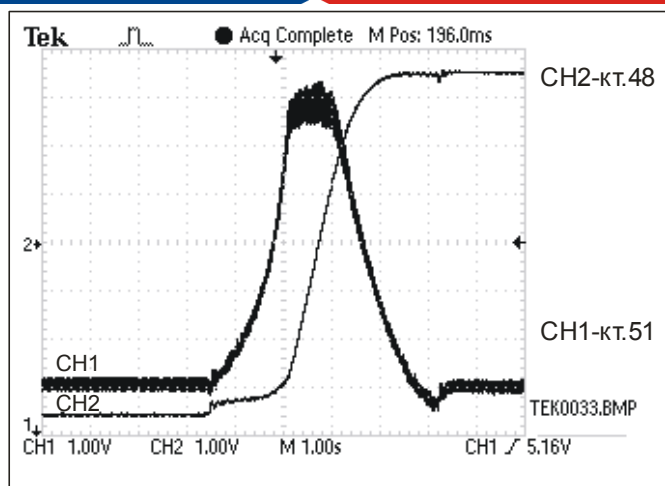


Figure 29 Form of the armature voltage and field current characteristics at optimal adjustment of the **EMF** regulator at reverse

For adjusting the EMF regulator use parameters **P07.03** and **P07.04**. Parameters **P07.03** and **P07.04** influence on the EMF regulator work as following:

- Parameter **P07.03** – coefficient of amplification of the EMF regulator. Typical values of the parameter **P07.03** are from 1.00 to 5.00. At high values of the parameter **P07.03** the tendency to selfexcitation increases. At low values of the parameter **P07.03** the overregulation of the armature voltage increases;
- Parameter **P07.04** – time constant of the **EMF** regulator. Typical values of parameter **P07.04** are from 5 to 50 ms. At low values of the parameter **P07.04** the reaction speed of the **EMF** regulator increases and the tendency to selfexcitation increases, too. At high values of parameter **P07.04** time to approaching the stable armature voltage increases;
- Parameter **P07.05** – differential time constnt of the **EMF** regulator. Typical values of the parameter **P07.05** are from 20 to 100% of the values of the parameter **P07.03**.

At high values of parameter **P07.03** and low values of parameter **P07.04** it is watched selfexcitation of the armature voltage during the transient. Armature voltage and field current characteristics with tendency to selfexcitation at reverse are given in **figure 30**.

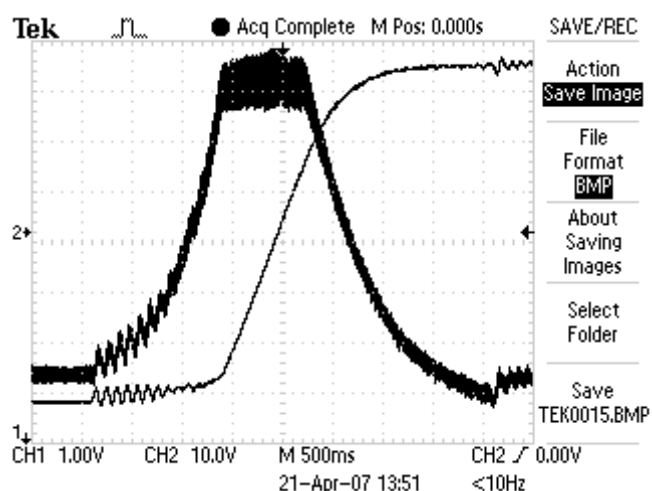


Figure 30 Armature voltage and field current with tendency to selfexcitation at high values of parameter **P07.03** and low values of parameter **P07.04**

At low value of parameter **P07.03** and high value of parameter **P07.04** it is watched overregulation of the armature voltage. Armature voltage and field current characteristics with overregulation are given in **figure 31**.

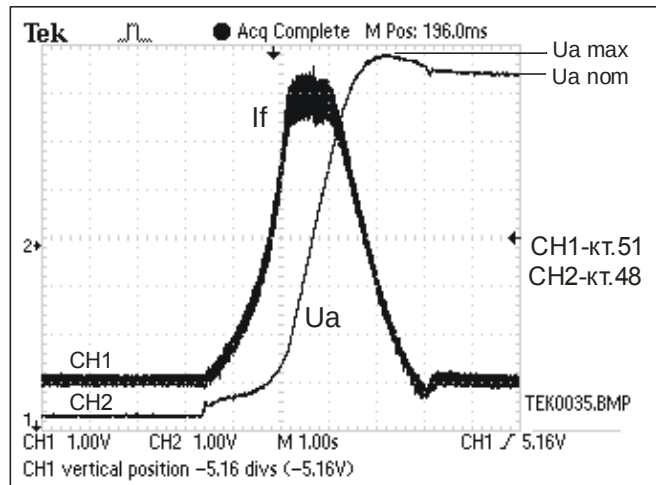


Figure 31 Armature voltage and field current characteristics with overregulation at low values of parameter **P07.03** and high values of parameter **P07.04**

When the **EMF** regulator and field current are adjusted wrong the protection **OVM** of over voltage of the armature activates – LED indication **OS** flicks with a period of time 0.3s. In this case it is recommended to start adjusting the **EMF** regulator at lower rotating speed and it increses gradually.

That the converter adjusting finishes.

ATTENTION!

The measurement of all signals are mde to the common ground – KT 16.

Numbering of the terminals of the motor tachogenerator in figure 16 and figure 17 corresponds to the motors made in “DINAMO” AD – Sliven. F1 and F2 are labels for beginning and the end of the field coil, A1 – label of the beginning of the armature coil, B2 – end of the compensational coil.

9. Possible troubles and remedy actions

Name, indication and situations	Possible reason	Method for testing and eliminating the problem
1. When the supply voltage is switched on, the protection SPF activates. LED PF lights constantly.	A phase absences or power and synchronization voltage are out of phase.	Check power and operative supply voltage, if there is in-phase and good quality of the connection. Check the ground.
2. When the device is on and the signal ON is given, the protection HPF activates. LED PF flicks with aperiod 1s.	A phase of the power supply voltage absences.	Check the status of power supply and the quality of the connection.
3. When the power supply voltage is switched on protection FRF activates. LED PF flicks with a period 0.3s	The frequency of the mains are out of limits 42 to 68Hz. The synchronization absences.	Check if there are synchronization voltages. Check the mains frequency. Check if there is $\pm 12V$.
4. When the power supply voltage is on and the signal ON is given the current switcher activates.	Thyristor has failed or short circuit in power block.	Disconnect the connection of power supply and motor armature. By ohmmeter check the resistance between terminals U2, V2, W2 to A1 , after that to B2 to define the thyristor that has failed.
5. When the device is on and signal ON is given the protection SOC or HOC activates. LED OC lights constantly or flicks with a period 1s.	Thyristor has failed, short circuit in motor armature circuit. Synchronization and power voltage are out of phase when the protection HPF (P03.07=0) is off.	Disconnect the connections of power supply and motor armature. By ohmmeter check the resistance between terminals U2, V2, W2 to A1 , after that to B2 to define the thyristor that failed. Check the correspondence between synchronization and power voltage.
6. When the device works at defined speeds the protection SOC or HOC activates. LED OC lights constantly or flicks with a period 1s.	High fluctuations in the speed feedback circuit.	1. Check the quality of the speed feedback in P01.12 at stable working speed and at meanings higher than 2% repair or replace the sensor. 2. If it is impossible to repair it is admissible to set in P06.07 from 150 to 200 ms.
7. When the device is on, the fuses FUT or FUS have blown.	Thyristor has failed, short circuit in the field block or motor wound.	Replace the failed thyristor. Diagnostics and repair the motor.
8. When the device is on, the signal ON is given and the reference is giving gradually the fuses FUT and FUS have blown.	Short circuit between motor field and armature. It is appeared when the field is without transformer.	By ohmmeter check the isolation resistance between field and armature circuits, and at value under 2 M Ω , the motor must be repaired.
9. When the signal ON and speed reference are given, in one of the directions at transient the usual "growling" of the motor is heard.	There are "missing" pulses in armature current.	The converter is starting in proportional mode at P02.06=1 and by parameter P01.17 define failed thyristor. Check the circuit of the controlling pulses and the thyristor itself.
10. When both signal ON and speed reference are active the motor loaded and the speed "fluctuates".	There is a shunt in the motor armature or in the tachogenerator.	Start the device in proportional mode and the motor starts to rotate as a "step" motor. Switch off the signal ON , and when there is field current rotate the motor shaft by hand. If the resistance moment increases in definite zones it means that there is a shunt in the motor armature. If the resistance moment does not increase that means that the shunt is in tachogenerator.
11. When the speed reference is over the nominal the device is not perform them and the protection OVM activates. LED OS flicks with a period of time 0.3s.	The device does not enter the second zone.	Check the value of parameter P02.07, P04.03 and P04.04 . Check whether the value of parameter P01.05 is more than the one of P04.01 . Check the supply phases of the field (do not use phase L1).

Name, indication and situations	Possible reason	Method for testing and eliminating the problem
12. After motor repairing, when it starts at low speed the device fluctuates the field current and the protection SFL activates. LED FL lights constantly.	The motor repairing is of poor quality.	Check the connection of the additional poles and the motor compensation coil.
13. After motor starts at low speed the protection STG activates. LED TG lights constantly.	The speed feedback (tachogenerator) is absent or the protection adjusting is wrong.	Check the connection of the tachogenerator and its good working order. Increase the value of parameter P03.12 .
14. After the motor starts at low speed the protection ENF activates. LED TG flicks with a period 1s.	The speed/position feedback is absent – encoder.	Check the connection of the encoder and its good working order.
15. After the motor starts at low speed the protection PSB activates. LED TG flicks with a period 0.3s.	Positive speed feedback.	Changing the sign of the speed feedback: - by tachogenerator with parameter P02.19 ; - by encoder with parameter P02.20 ;
16. After activating the signal ON the protection SFL activates. LED FL lights constantly.	Wrong chosen parameters P04.02 and P03.13 or fluctuating of the field current regulator.	Check the value of parameters P04.02 and P03.13 . If it is necessary set the value of P03.13 in range from 115÷130% of P04.02 . Adjust the field current regulator by parameters P07.01 and P07.02 .
17. After activating the signal ON and speed reference is near to maximum the protection SFL activates. LED FL lights constantly.	Wrong chosen parameters P04.03 , P04.04 and P03.14 .	Check the values of parameters P04.03 , P04.04 and P03.14 and if it is necessary set the value of P03.14 in range 50÷80% of the value of parameter P04.03 .
18. After activating the signal ON and speed reference is near to maximum the protection SOS activates. LED OS lights constantly.	Overspeeded maximum speed.	Check the value of parameter P03.10 .
19. During the work the protection OLF (I²t) activates. LED OL lights constantly.	Overloaded motor.	Check the machine working modes. If it is necessary replace the device with more powerful device. Check the value of P03.08 .
20. During the work the protection OHF activates. LED OL flicks with a period 1s.	Overheated power block.	Switch off and cool the converter. Provide the converter power block with better ventilation.
21. After giving the signal ORCM (orientation stopping) the protection ENF activates. LED TG flicks with a period 1s.	Position feedback absences.	Check the circuit of the encoder for presence and absence. Check the encoder.

PASSPORT

THYRISTOR MAIN CONVERTER FOR DC MOTOR WITH INDEPENDENT EXCITATION

TYPE:

S. No:

Software:

ELL
Bulgaria 8801
Sliven, P.O.B. 1207
1, Stoil voyvoda Square, floor 2
tel: ((+359 44) 667 226
e-mail: ell@ell-bg.com

fax: ((+359 44) 667 933
<http://www.ell-bg.com>

Guarantee card

Name of the device :

“Thyristor main converter for main motor with independent excitation
type:.....”

Series №:

Date of made:

Guarantee period - 24 months of the date of starting operation, but no more than 27 months of date of made.

Manager : _____
/ /

Guarantee ovligations

1. The produser guarantees good working order of the device when there are not damages during the transport and at conditions of operation, given in user's manual.
2. The device which is out of order during the guarantee period through producer's fault is put in a claim.
3. The guarantee falls away if any of the components of the device is repaired by a person without the requisite qualification.
4. The damages made by careless operation and when the device is connected to mains which does not respond to the norms, are at user's expense.
5. For all questions connected with operation or repairing the device, the client must call the produser.

Set of the delivery

- | | |
|----------------------------|---------------|
| • Converter | - 16p. |
| • User's | - 16p. |
| Passport | - 16p. |
| Table of parameters | - 16p. |

TABLE OF PARAMETERS

CONVERTER, TYPE:
SERIES №:

1. HARDWARE ADJUSTMENT

Power supply voltage
 Nominal armature current
 Maximum armature current
 Maximum armature voltage
 Nominal wound field current
 Maximum wound field voltage
 Tachogenerator
 Digital inputs
 Digital outputs

2. SOFTWARE ADJUSTMENT – MEANING OF PARAMETERS

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
Group 01 – watching parameters					
P01.01	Current value of speed reference	-	% N _{MAX}	-	-
P01.02	Current value of actual speed	-	% N _{MAX}	-	-
P01.03	Current value of the armature current reference	-	A	-	-
P01.04	Current value of the armature actual current	-	A	-	-
P01.05	Current value of the armature voltage	-	V	-	-
P01.06	Current value of the wound field current	-	A	-	-
P01.07	Digital inputs IN1 – IN10 status	-	code	-	-
P01.08	Digital inputs IN10 – IN18 status	-	code	-	-
P01.09	Reserved	-	-	-	-
P01.10	Digital output status	-	code	-	-
P01.11	Reserved	-	-	-	-
P01.12	Test of the speed feedback	-	% U _{br}	-	-
P01.13	Current value of the mains frequency	-	Hz	-	-
P01.14	Current maximum deviation in synchronization	-	μs	-	-
P01.15	Maximum number recorded breaks in synchronization	-	-	-	-
P01.16	Maximum number recorded breaks in power supply	-	-	-	-
P01.17	Power thyristor status	-	code	-	-
P01.18	Current value of the encoder pulses	-	imp	-	-
Group 02 – converter parameters					
P02.01	Version of the converter software	-	-	-	-
P02.02	Password of access	11	-	0	-
P02.03	Restore in default of meaning	0, 1	-	0	-
P02.04	Imagine of the user's parameters	0, 1	-	0	-
P02.05	Reading of the user's parameters	0, 1	-	0	-
P02.06	Converter working mode	-1, 0, 1, 2	-	0	-
P02.07	Work with weakened field	0, 1, 2	-	1	-
P02.08	Scaling the converter nominal current I _{drV} _{NOM}	5.0 ÷ 500.0	A	34.0	-
P02.09	Converter power supply	100 ÷ 440	V	380	-
P02.10	Range of the field current sensor	1.5A – 20.0A	-	6.5 A	-
P02.11	Type of the field current sensor	6A/15A/25A	-	25 A	-
P02.12	Sensor of the armature current – calculating R65,R66,R67	-	Ohm	-	-

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P02.13	Mode “emergency stopping”	0, 1, 2	-	1	
P02.14	Choice of the speed reference source	0, 1, 2, 3	-	2	
P02.15	Inner speed reference	-100.00 ÷ 100.00	% N _{MAX}	0.00	
P02.16	Type of speed feedback	0, 1, 2	-	0	
P02.17	Change the speed reference sign	0, 1	-	0	
P02.18	Limitation of the maximum value of the speed reference	1.00 ÷ 100.00	% N _{MAX}	100.00	
P02.19	Changing the sign of the speed feedback with tachogenerator	0, 1	-	0	
P02.20	Changing the sign of the speed feedback with encoder	0, 1	-	0	
P02.21	Encoder resolution	100.0 ÷ 2500.0	имп. / об.	1024.0	
P02.22	First maximum speed	100 ÷ 10 000	min-1	3500	
P02.23	Second maximum speed	100 ÷ 10 000	min-1	3500	
P02.24	Third maximum speed	100 ÷ 10 000	min-1	3500	
P02.25	Fourth maximum speed	100 ÷ 10 000	min-1	3500	
P02.26	Enable switching on of the maximum speed	0, 1	-	0	
P02.27	Source of the armature circuit resistance	0, 1	-	0	
Group 03 – protection parameters					
P03.01	Admissible number breaks in synchronization - protection SPF	5 ÷ 50	-	10	
P03.02	Maximum number recorded breaks in synchronization - protection SPF	-	-	-	-
P03.03	Maximum admissible deviation in synchronization - protection SPF	100 ÷ 800	μs	400	
P03.04	Current maximum deviation in synchronization - protection SPF	-	μs	-	-
P03.05	Admissible number breaks in mains - protection HPF	5 ÷ 50	-	10	
P03.06	Maximum number recorded breaks in mains - protection HPF	-	-	-	-
P03.07	Working mode of protection HPF	0, 1	-	1	
P03.08	Time of activating protection OLF (I ² t) of motor overloaded	0.1 ÷ 100.0	s	10.0	
P03.09	Working mode of protection OHF	0, 1	-	0	
P03.10	Limit admissible speed N _{LIM} – protection SOS	100.0 ÷ 110.0	% N _{MAX}	105.0	
P03.11	Converter limit current I _{drvLIM} - protection SOC	105.0 ÷ 125.0	% Ia _{MAX}	115.0	
P03.12	Armature voltage when the protection STG activates	40.0 ÷ 80.0	% U _{amax}	50.0	
P03.13	Wound field maximum current I _{FLMAX} – protection SFL	> P04.02	A	3.878	
P03.14	Wound field minimum current I _{FLMIN} – protection SFL	≤ P04.04	A	0.166	
P03.15	Limit error of tracking - protection OTE	10 ÷ 200 000	imp	4096	
P03.16	Working mode of protection OTE	0, 1	-	1	
P03.17	Limit armature voltage – protection OVM	105.0 ÷ 120.0	% U _{aMAX}	115.0	
P03.18	Time to stable the field current – protection FWF	2.0 ÷ 20.0	s	5.0	
P03.19	Working mode of the protection OLF	0, 1	-	1	
Group 04 – motor parameters					
P04.01	Maximum armature voltage U _{aMAX}	100 ÷ 450	V	400	
P04.02	Field nominal current I _{FNOM}	≥ P04.05 ÷ P02.10	A	3.394	
P04.03	Field minimum working current I _{FMIN2} in 2 zone	≥ P04.04 ≤ P04.02	A	0.678	
P04.04	Minimum working field current I _{FMIN3} in 3 zone	≥ P03.14 ≤ P04.04	A	0.678	
P04.05	Wound field current I _{FON} when the signal ON is off	≥ P03.14 ≤ P04.02	A	1.697	
P04.06	Nominal motor speed on the table	100 ÷ P04.07	min-1	1000	
P04.07	Maximum motor speed on the table	100 ÷ 10000	min-1	3500	
P04.08	Actual maximum motor speed	100 ÷ P04.07	min-1	3500	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P04.09	Maximum armature current Ia_{MAX} in p.1	200.00÷P04.10	%	200.00	
P04.10	Maximum armature current Ia_{MAX} in p.2	P04.09÷P04.11	%	100.00	
P04.11	Maximum armature current Ia_{MAX} in p.3	P04.10 ÷20.00	%	100.00	
Group 05 – speed regulator parameters					
P05.01	Time of the rampgenerator	0.0 ÷ 20.0	s	2.5	
P05.02	Offset of speed reference	-1024 ÷ 1024	-	0	
P05.03	Coefficient of amplification of the speed regulator Kp1	0.1 ÷ 100.0	-	25.0	
P05.04	Coefficient of amplification of the speed regulator Kp2	0.1 ÷ 100.0	-	12.5	
P05.05	Work threshold of the coefficient of amplification Kp1	0.10 ÷ P05.06	%	0.75	
P05.06	Work threshold of the coefficient of amplification Kp2	P05.05 ÷ 100.00	%	2.25	
P05.07	Time constant of speed regulator Tn1	20 ÷ 2000	ms	150	
P05.08	Time constant of speed regulator Tn2	20 ÷ 2000	ms	300	
P05.09	Work threshold of time constant Tn1	0.10 ÷ P05.10	%	0.75	
P05.10	Work threshold of time constant Tn2	P05.09 ÷ 100.00	%	2.25	
P05.11	Differential component Dt1	0.0 ÷ 100.0	-	10.0	
P05.12	Differential component Dt2	0.0 ÷ 100.0	-	10.0	
P05.13	Working threshold of the differential component Dt1	0.10 ÷ P05.14	%	0.75	
P05.14	Working threshold of the differential component Dt2	P05.13 ÷ 100.00	%	2.25	
Group 06 – armature current regulator parameters					
P06.01	Coefficient of amplification of the armature current regulator	0.01 ÷ 2.00	-	0.13	
P06.02	Time constant of armature current regulator	10.0 ÷ 200.0	ms	15.0	
P06.03	Adjusting of the current amplitude of phase L1	-512 ÷ 512	discretes	0	
P06.04	Adjusting of the current amplitude of phase L2	-512 ÷ 512	discretes	0	
P06.05	Adjusting of the current amplitude of phase L3	-512 ÷ 512	discretes	0	
P06.06	Offset of the armature current	-50 ÷ 50 % of P02.08	A	0.0	
P06.07	Time of the armature current rampgenerator	0 ÷ 500	ms	0	
Group 07 – EMF and field regulators parameters					
P07.01	Coefficient of amplification of the field current regulator	0.01 ÷ 10.00	-	0.50	
P07.02	Time constant of the field current regulator	10 ÷ 2000	ms	120	
P07.03	Coefficient of amplification of the EMF regulator	0.01 ÷ 10.00	-	2.00	
P07.04	Time constant of EMF regulator	10 ÷ 2000	ms	200	
P07.05	Differential component of the EMF regulator	0.01 ÷ 10.00		0.50	
Group 08 – orientation stopping parameters					
P08.01	Running acceleration 1	1 ÷ 20000	-	200	
P08.02	Stopping acceleration 1	1 ÷ 20000	-	200	
P08.03	Running acceleration 2	1 ÷ 20000	-	40	
P08.04	Stopping acceleration 2	1 ÷ 20000	-	40	
P08.05	Coefficient of amplification of the position regulator Kp	0.05 ÷ 200.00	-	1.00	
P08.06	Enable of the position tracking mode	0, 1	-	0	
P08.07	Current tracking error		imp	0	
P08.08	Recorded maximum tracking error	-	imp	0	
P08.09	Adjusting the tracking error	0.00 ÷ 200.00		18.00	
P08.10	Position window	1 ÷ 20000	imp	16	
P08.11	Time of position stabling	0 ÷ 10000	ms	5000	
P08.12	Current position error	-	imp	0	
P08.13	Zero position	≤ P02.21 x4	imp	0	
P08.14	Speed of fixing in zero position	1 ÷ 2000	min-1	100	
P08.15	Speed direction at searching zero position	0, 1, 2		2	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P08.16	Speed source at searching zero position	0, 1		0	
P08.17	Speed at searching zero position	1 ÷ 1000	min-1	40	
Group 09 – parameters of the digital inputs					
P09.01	Type of the digital input IN1	0 ÷ 40	-	27	
P09.02	Inverting of the logical level of digital input IN1	0, 1	-	0	
P09.03	Type of the digital input IN2	0 ÷ 40	-	28	
P09.04	Inverting of the logical level of digital input IN2	0, 1	-	0	
P09.05	Type of the digital input IN3	0 ÷ 40	-	29	
P09.06	Inverting of the logical level of digital input IN3	0, 1	-	0	
P09.07	Type of the digital input IN4	0 ÷ 40	-	30	
P09.08	Inverting of the logical level of digital input IN4	0, 1	-	0	
P09.09	Type of the digital input IN5	0 ÷ 40	-	31	
P09.10	Inverting of the logical level of digital input IN5	0, 1	-	0	
P09.11	Type of the digital input IN6	0 ÷ 40	-	32	
P09.12	Inverting of the logical level of digital input IN6	0, 1	-	0	
P09.13	Type of the digital input IN7	0 ÷ 40	-	33	
P09.14	Inverting of the logical level of digital input IN7	0, 1	-	0	
P09.15	Type of the digital input IN8	0 ÷ 40	-	34	
P09.16	Inverting of the logical level of digital input IN8	0, 1	-	0	
P09.17	Type of the digital input IN9	0 ÷ 40	-	35	
P09.18	Inverting of the logical level of digital input IN9	0, 1	-	0	
P09.19	Type of the digital input IN10	0 ÷ 40	-	36	
P09.20	Inverting of the logical level of digital input IN10	0, 1	-	0	
P09.21	Type of the digital input IN11	0 ÷ 40	-	13	
P09.22	Inverting of the logical level of digital input IN11	0, 1	-	0	
P09.23	Type of the digital input IN12	0 ÷ 40	-	14	
P09.24	Inverting of the logical level of digital input IN12	0, 1	-	0	
P09.25	Type of the digital input IN13	0 ÷ 40	-	2	
P09.26	Inverting of the logical level of digital input IN13	0, 1	-	0	
P09.27	Type of the digital input IN14	0 ÷ 40	-	11	
P09.28	Inverting of the logical level of digital input IN14	0, 1	-	0	
P09.29	Type of the digital input IN15	0 ÷ 40	-	9	
P09.30	Inverting of the logical level of digital input IN15	0, 1	-	0	
P09.31	Type of the digital input IN16	0 ÷ 40	-	10	
P09.32	Inverting of the logical level of digital input IN16	0, 1	-	0	
P09.33	Type of the digital input IN17	0 ÷ 40	-	3	
P09.34	Inverting of the logical level of digital input IN17	0, 1	-	0	
P09.35	Type of the digital input IN18	0 ÷ 40	-	1	
P09.36	Inverting of the logical level of digital input IN18	0, 1	-	0	
Group 10 – output parameters					
P10.01	Speed threshold N_{ZS} , under which protection ZS activates	0.01 ÷ 15.00	% N_{MAX}	2.00	
P10.02	Time of confirming of the change of ZS	1 ÷ 1000	ms	100	
P10.03	Speed threshold N_{SA} , over which protection SA activates	1.00 ÷ 30.00	% N_{REF}	15.00	
P10.04	Time of confirming of the change of SA	1 ÷ 1000	ms	100	
P10.05	Speed from which SA starts work	0.01 ÷ 15.00	% N_{MAX}	2.00	
P10.06	Time of confirming of the change of INPOS	1 ÷ 1000	ms	100	
P10.07	Maximum armature current $I_{a_{TLH}}$ at control signal TLH	10.0 ÷ 100.0	% $I_{a_{NOM}}$	50.0	
P10.08	Maximum armature current $I_{a_{TLL}}$ at control signal TLL	1.0 ÷ 100.0	% $I_{a_{NOM}}$	20.0	
P10.09	Type of the relay output OUT1	0 ÷ 10	-	1	
P10.10	Inverting the logical level of the output OUT1	0, 1	-	0	
P10.11	Type of the relay output OUT2	0 ÷ 10	-	2	
P10.12	Inverting the logical level of the output OUT2	0, 1	-	0	

№	Name of the parameter	Limits of variation	Measure	Meaning	New meaning
P10.13	Type of the relay output OUT3	0 ÷ 10	-	3	
P10.14	Inverting the logical level of the output OUT3	0, 1	-	0	
P10.15	Type of the relay output OUT4	0 ÷ 10	-	4	
P10.16	Inverting the logical level of the output OUT4	0, 1	-	0	
P10.17	Type of the relay output OUT5	0 ÷ 10	-	5	
P10.18	Inverting the logical level of the output OUT5	0, 1	-	0	
P10.19	Choice of the variable of analog output AOUT1	1 ÷ 12	-	1	
P10.20	Choice of the variable of analog output AOUT2	1 ÷ 12	-	1	
P10.21	Range of analog output AOUT1	2.0 ÷ 10.0	V	10.0	
P10.22	Range of analog output AOUT2	2.0 ÷ 10.0	V	10.0	
Group 11 – terminal parameters					
P11.01	Adjusting terminal language	0, 1, 2	-	0	
P11.02	Time of indication refreshing	1 ÷ 1000	ms	500	
Group 12 – error history					
P12.01	error 1	-	-	EMPTY	
P12.02	error 2	-	-	EMPTY	
P12.03	error 3	-	-	EMPTY	
P12.04	error 4	-	-	EMPTY	
P12.05	error 5	-	-	EMPTY	
P12.06	error 6	-	-	EMPTY	
P12.07	error 7	-	-	EMPTY	
P12.08	error 8	-	-	EMPTY	
P12.09	error 9	-	-	EMPTY	
P12.10	error 10	-	-	EMPTY	
P12.11	error 11	-	-	EMPTY	
P12.12	error 12	-	-	EMPTY	
P12.13	error 13	-	-	EMPTY	
P12.14	error 14	-	-	EMPTY	
P12.15	error 15	-	-	EMPTY	
P12.16	error 16	-	-	EMPTY	
P12.17	Error reset	0, 1	-	0	

Notes:

1. Password of access to editing of the parameters is 11.
2. Parameters in dark field can be changed only after inserting the password and the control signal ON is switched off.

Examiner:	Sign:	Date:
-----------	-------	-------

